THURSDAY, JANUARY 20, 1887

THE IMPERIAL INSTITUTE

FOR some time before the scheme of the Prince of Wales's Committee was before the public, there was a feeling that it seemed only too probable that the Imperial Institute would be merely a show-place for the amusement of sight-seers and for the benefit of the showmen. Happily this danger has been averted. Prof. Huxley and others have sounded a note which has now brought the real basis of trade and commerce to the front. It is possible that the mere trade-product view will now give way, so that we may hope the scheme in its final form will be hardly less scientific than that sketched by us in the first of our articles on "Science and the Jubilee" (p. 217). If this anticipation is realised, the Institute will be in every sense a worthy memorial of the fiftieth anniversary of the Queen's reign, and will prove to be of enduring benefit to the whole Empire. There cannot be the slightest doubt as to the necessity for a vital change in our national way of regarding scientific as if they were opposed to industrial methods. There was a time when England, with her monopoly of coal and iron, had practically no competitors in the great markets of the world. By the splendid achievements of her inventors, and by the energy and promptitude of her manufacturers and traders, she had got so far—having such a monopoly of raw material—ahead of her rivals that the foremost place in commerce seemed to belong to her by a sort of natural right. Within the lifetime of the present generation all this has been changed. France, Germany, and other nations gradually became aware that they also, if they pleased, might play a prominent part in the industrial movement, and they set to work in the right way to fit themselves for the new conditions of modern life. Recognising that permanent success could be accomplished only by knowledge and organised effort, they provided for the education both of employer and employed by the establishment of schools, and by every means at their disposal encouraged the development of science. The consequence is that England has been driven from some markets in which she was formerly supreme, and that in others she finds it hard to maintain her ancient predominance. There is not the faintest chance that she will recover the ground she has lost unless she chooses to adapt herself to the altered circumstances by which she is surrounded. In commerce, as in all other relations, it is the fittest that survives; and if raw material fails, then greater knowledge alone can triumph; and the fittest commercial nation is the nation which equips its workers with the most exact knowledge, the most alert intelligence, and the most thorough technical skill. If the Imperial Institute is founded and carried on in accordance with the best and most characteristic ideas of our time, it may make Greater Britain greater yet, if it helps to bring British industry under the dominion of the scientific spirit; and to secure for it this magnificent position ought unquestionably to be the aim of all who undertake to press its claims on the attention of the public.

This aspect of the subject was kept prominently in view by all the principal speakers at the meetings in St. James's Palace and the Mansion House last week. The Prince of Wales laid the strongest emphasis on the fact that, in all parts of the civilised world, commerce and manufactures have been profoundly affected by the progress of science. "I have, on more than one occasion," he said, "expressed my own views, founded upon those so often enunciated by my lamented father, that it is of the greatest importance to do everything within our power to advance the knowledge, as well as the practical skill, of the productive classes of the Empire. I therefore commend to you, as the leading idea I entertain, that the Institute should be regarded as a centre for extending knowledge in relation to the industrial resources and commerce of the Queen's dominions. With this view it should be in constant touch, not only with the chief manufacturing districts of this country, but also with all the colonies and India. Such objects are large in their scope, and must necessarily be so, if this Institute is worthily to represent the unity of the Empire."

Prof. Huxley spoke at the Mansion House and, of all the speeches delivered there, his was the most striking. As the present needs of the nation, and how an Imperial Institute might be made to help us, are never likely to be more lucidly or more impressively stated, it seems to us that we shall do our readers good service by printing the speech in full. Seconding the resolution proposed by Lord Rothschild, "That this meeting pledges itself to take all practicable steps to assist in the formation of the Imperial Institute, and to support it when brought into existence," Prof. Huxley said:—

"He wished to state, very briefly, his opinion of the value of the proposed Institute from the point of view of a man of science. The epoch coincident with Her Majesty's reign was remarkable above all corresponding periods of human history that he knew anything about for two peculiarities. One was the enormous development of industry, and the other was the no less remarkable and prodigious development of physical science, which two developments, indeed, had gone hand in hand. The opinion which he was now expressing was not one formed *ad hoc* for the purpose of this meeting. It was one which he expressed two or three years ago when taking leave of the Royal Society. It was a matter which was perfectly obvious to any person who had paid attention either to the history of science or to the history of industry, that there had been nothing, not only in any period of fifty years, but in any century, in the slightest degree comparable with the magnitude and the importance of the growth of those two branches of human activity which had taken place since 1837. His memory went back far enough to call to mind with great vividness a period when industry, or, at least, the chiefs and the leaders of industry, looked very much askance at science. The practical man then prided himself on caring nothing for it, and made it a point to disbelieve that any advantage to industry could be gained by the growth of what he was pleased to call abstract and theoretic knowledge. But within the last thirty years more particularly that state of things had entirely changed. There began in the first place a slight flirtation between science and industry, and that flirtation had grown into an intimacy, he might almost say courtship, until those who watched the signs of the times saw that it was high time that the young people married and set up an establishment for themselves. This great scheme, from his point of view, was the public and ceremonial marriage of science and industry. It

was the recognition on the part of those persons who were best able to judge of what were the wants of the industry of the time, that, if they were to be developed in a way proportionate to their importance, they must be developed by scientific methods and by the help of a thoroughly scientific organisation. A great distinction was commonly drawn by some philosophic friends of his between what they called militarism and what they called industrialism, very much to the advantage of the latter. He by no means disputed that position; but he would ask any one who was cognisant of the facts of the case, who had paid attention to what was meant by modern industry pursued by the methods now followed, whether, after all, it was not war under the forms of peace? It was perfectly true that the industrial warfare was followed by results far more refined in their character than those which followed in the track of military warfare. It did not break heads and shed blood, but it starved. The man who succeeded in the war of competition and the nation which succeeded in the war of competition beat their opponents by his starvation. It was a hard thing to say, but the plain simple fact of the case was that industrial competition among the peoples of the world at the present time was warfare which must be carried on by the means of warfare. In what respect did modern warfare differ from ancient warfare? It differed because it had allied itself with science, because it trusted in knowledge, organisation, and discipline, and not in mere physical strength and numbers, because it took advantage of every scientific discovery by which the weapons of offence and defence could be perfected, and because it required the highest possible information on the part of those who were engaged in that warfare; and if the peaceful warfare of industrialism was to succeed it must follow the same methods. The operations of the leaders of industry must be organised; they must call to their aid, as military leaders were doing, every possible help which was to be gathered from science. They all knew what help science was already giving to industry; it would not do to remain contented with this accidental aid, but those who conducted industrial operations should be trained and disciplined in those different branches of human knowledge which dealt with the needs and wants of nations and with the distribution of commodities. This country had dropped astern in the race for want of that education which was obtained elsewhere in the highest branches of industry and commerce. It had dropped astern in the race for want of instruction in technical education which was given elsewhere to the artisan; and if they desired to keep up that industrial predominance which was the foundation of the Empire, and which, if it failed, would cause the whole fabric of the State to crumble—if they desired to see want and pauperism less common than unhappily they were at present, they must remember that one of the chief means of diminishing those evils was the organisation of industry in the manner in which they understood organisation in science, that they must strain every nerve to train the intelligence that served industry to its highest point, and to keep the industrial products of England at the head of the markets of the world. He looked, therefore, on the Institute as the first formal recognition of this great fact—that our people were becoming alive to the necessity of organisation of industry and the improvement of industrial knowledge. It was on that ground that he supported the proposition. It appeared to him that it would be a worthy and fitting memorial of Her Majesty's reign, if they created an institution which permanently represented that which was the great and characteristic feature of the period, that which would mark the Victorian epoch in history as the epochs of Augustus and Pericles had been marked. An Institute having such objects and purposes as had been described appeared to him to be a monument not only more lasting than brass but one which for centuries to come would hold before the people an image of the objects after which they had to strive, if they desired to organise their activities in such a manner as would lead to their perennial welfare."

This admirable statement by Prof. Huxley it is to be hoped will be read by everybody interested in the welfare of Greater Britain. It will not be enough, however, to see that the army of peace is alone organised within one Institute only, however Imperial it may be.

Our chief want now is knowledge in high places. We do not forget that in our present Prime Minister we have a patient student of science, and one who knows the need of it for the country. But there are a thousand ways in which the ignorance, or rather let us say the want of scientific instruction and of appreciation of the fact that a modern State can only be great on account of its commerce and of its superiority in all international relations, and that greatness in these directions depends upon *knowledge*, is doing this country great harm.

We are not without signs that this also is being recognised. The *Times*, in a remarkable leading article the other day, pointing out the importance of meteorology—and the moral it draws would have been equally true of any other branch of knowledge—writes as follows:—

"Meteorology is a science of great practical importance and of great speculative interest, which is pursued in this country under considerable disadvantages. The Atlantic starves it on one side, and the Treasury on the other. It exists within an area of permanent depression. The Government does dole out something for its support, but it takes a large part of it back in the shape of telegrams. While the Atlantic curtails our horizontal information of the condition of the atmosphere, Nature has given us mountains which offer valuable opportunities for vertical investigation. A few earnest men of science and public-spirited citizens have set up an observatory on Ben Nevis at a cost of more than five thousand pounds, and, beyond allowing twopence in the shilling upon telegrams despatched from the top, the Government, we believe, does nothing for its support. It even charges a heavy rent for the telegraph-wire. This nation thinks nothing of wasting, by improvident method, in the building of a single ironclad as much money as would maintain all our scientific establishments for a decade. But while there is the most indefensible squandering of public money at the War Office and the Admiralty, there is the meanest parsimony towards science and scientific education—the only things that, as Prof. Huxley pointed out the other day, can save us from being crushed in the fierce competition of peace, which kills as surely as that of war. The Treasury knows in a vague sort of way what an ironclad is, but we doubt whether there are three men in the department who could give an intelligent definition of physics."

Assuming that the *Times*' estimate of the knowledge available at the Treasury is exact, our point is that it is the system and not the individuals who should bear the blame. Nor is the Treasury the only department in which a knowledge of science is imperative, or in which successive Ministries have taken no action to provide it.

It is well that all these questions should now be raised, and the more questions of this order are raised by the Institute movement the better for us will it be.

THE BLASTOIDEA

Catalogue of the Blastoidea in the Geological Department of the British Museum (Natural History); with an Account of the Morphology and Systematic Position of the Group, and a Revision of the Genera and Species. By Robert Etheridge, Jun., and P. Herbert Carpenter, D.Sc., F.R.S. Illustrated by 20 Lithographic Plates, &c. (London: Printed by Order of the Trustees, 1886.)

THIS important memoir is in all but in name a monograph of the interesting group of extinct Echinoderms first called Blastoidea by Thomas Say in 1825. It originated, the authors tell us, some seven years ago, in a desire to investigate the structure and relationships of this group by the light of the recent advances made in our knowledge of their living representatives.

Echinoderm structure owes much to the genius and labours of Johannes Müller, and a knowledge of the results of his inquiries largely influenced Prof. F. Roemer in preparing his classical work on the Blastoidea. Recent investigations have added enormously to our knowledge of the structure of the Stalked Echinoderms, so that a renewed morphological examination of their extinct allies was in every way desirable, and this we have now before us. The authors were indebted for much kindly aid in the examination of specimens to a whole host of friends, among whom it seems desirable to mention more especially Mr. Wachsmuth, who sent from America a selected series of forms from his fine collection of American Blastoidea, thus enabling the authors to form their own views on many points of structure. He also supplied them with recent information as to the progress of his own investigations among the American species.

The memoir begins with a chapter on the bibliographical history of the group, commencing with the paper by Say in the Journal of the Philadelphia Academy of Natural Science for 1885. Roemer's monograph appeared in 1852. Billings, in 1869, published a series of important memoirs, in which he suggested that the remarkable lamellar tubes beneath and between the ambulacra appeared to have served the function of respiration, and designated them as "hydrospires;" the summit openings in connection with them were called "spiracles." Wachsmuth's valuable contributions commenced in 1877, while in 1882 the present authors began a series of memoirs, which have now culminated in the present work. A second chapter treats of the Stem and Calyx. The stem of the Blastoidea would appear to be but little known, since individuals in which the stem remains attached to the calyx are rarely found. Mr. Wachsmuth has a slab of Pentremites, in which three specimens have stems of between 5 and 8 inches in length, and the best preserved stem examined by the authors is figured as occurring beneath the calyx of *Granatocrinus norwoodi*, where it is seen to consist of some small thin discoidal joints, which are so little characteristic, that if found isolated it could not be certainly said whether they belonged to a Blastoid or a Crinoid. Though all the Blastoids may have had stems in their early stages, some appear to have had no stem in their adult state. It will be remembered that the adult Comatula shows no trace whatever of having at one time been a stalked form. The calyx is described at great length and with great clearness, and the views of Wachsmuth and others are criticised. Chapter III. is devoted to the study of the Ambulacra, and the fourth chapter to the Summit Plates. These latter were first discovered by Owen and Shumard (1850) forming a conical covering of small plates over the oral and ovarial apertures on a specimen of *Pentremites godoni*. With the exception of Hambach, no recent palæontologist disputes that these plates are an integral part of the organisation of a Blastoid. The chapter on the Hydrospires and Spiracles is full of interest. The former can in no way be regarded as a respiratory portion of the ambulacral system, while the analogy of recent Crinoids goes to show that the ambulacral groove of the Blastoids was a ciliated food-groove, and that it was not occupied by any portion of the generative system; but the authors adopt Ludwig's comparison of the marsupial pouches (genital bursæ) of Ophiurids with the Blastoid hydrospires. The zoological position of the Blastoids is still regarded as a subject of discussion, though it would seem that Say's opinion is correct, and that the Blastoidea may be regarded as a group intermediate between the Crinoidea and Echinoidea. As to the distribution in time, there is no certain evidence of the existence of true Blastoidea anterior to the Upper Silurian period, and it is curious that all the known species of this period are confined to North American strata. The Devonian rocks of the British Islands have yielded but imperfect traces of them. The Lower Devonian rocks in France and in Belgium have each yielded a single Blastoid, but the great centre of their development in Europe during this geological period was in the north of Spain. In North America they were, on the contrary, largely represented, both in generic and specific forms. Regarding the Blastoids of the Devonian system from a general point of view, the number of genera was largely increased at the close of the Silurian period, and all the families are to be found represented in the Devonian period. Pentremites, which is the type form of the class, did not make its appearance until the Devonian. The Carboniferous rocks of the British Islands are rich in Blastoid forms, which are also to be found in Belgium, and were well developed in the sub-Carboniferous rocks of North America. No Blastoid is common to America and Europe, and in Europe the range of specific forms is very limited, though one species is found common to the Devonian of Spain and Germany, and one to the Carboniferous rocks of Britain and Belgium.

A most useful stratigraphical list of all known species, arranged geographically, is given, and then follows the descriptions of the species, to which it is not needful to allude further than to state that the greatest care has been taken, not only with the diagnoses, but with the synonyms and the distribution. A copious index and twenty beautifully executed plates complete the volume. Some sixteen of the plates were drawn on stone by the aid of a grant from the Government Grant Fund of the Royal Society, and, with the approval of the Council, and certainly to the advancement of science, were transferred to the Trustees of the British Museum, by whose order this "Catalogue" has been published.

TEA-PLANTING IN CEYLON

The Tea-Planter's Manual. By T. C. Owen. Pp. 162, with Coloured Lithographed Plates of an Iron and a Wood and Stone Tea Factory drawn to scale. (Colombo, Ceylon: A. M. and J. Ferguson, 1886.)

EIGHT years ago, on account of the depression in the coffee industry of Ceylon, the prospects of the colony were of a sufficiently gloomy character. A great improvement has, however, been effected by the partial substitution of tea and cinchona for coffee, and by the general attention given to cacao, cardamoms, and other subsidiary subjects. Ceylon has also been fortunate in possessing a practical scientific institution in the Botanical Gardens of the colony; and its local press is enterprising and well-informed.

It is well to mention here that the excellent growth made by tea plants at the Perideniya and Hakgala Gardens fully justified the advocacy of tea-planting in Ceylon by the late Dr. Thwaites in his Annual Reports, while it is also due to the Colonial Office to state that through Lord Blachford it warmly supported the introduction of Assam tea plants into Ceylon in 1867. In 1877 Ceylon tea in commercial samples was submitted, through the Royal Gardens, Kew, to the Indian Committee of the Society of Arts, and the Report of this Committee clearly foreshadowed the high place which Ceylon tea has since taken in the London market.

The present manual is one of a series issued by the *Ceylon Observer* press, and is intended to be a complete hand-book to all the multifarious duties of a successful tea-planter. Colonel Money's "Essay," and the "Tea-Planter's Vade Mecum," both publications having special reference to the circumstances of Indian gardens, have hitherto been the only books on the subject.

As stated in the preface, Mr. Owen's manual "is more a compilation of the opinions of others and the results they have arrived at than an original work." The very valuable notes of one of the earliest and most successful of Ceylon tea-planters, Mr. Armstrong, of Rookwood, form an important portion of the book. The compiler wisely avoids an extended disquisition on the original home of the tea plant and on the question whether the "Assam tea tree" and the "China bush" are specifically distinct. In the latest works on the subject they are both included under *Camellia theifera*, Griff. There is no doubt that the Assam tea tree—for in a wild state it often reaches 40 to 50 feet in height—is indigenous to the mountainous district lying between South-Western China and the River Brahmaputra. It is probable also, although not clearly proved, that the China tea plant—of a somewhat shrubby habit—is derived from the same stock; although, as we now know, it was greatly altered by persistent cultivation for several centuries in a soil and climate different from those of its original home. The China tea plant has been found wild in no part of China. Under cultivation in Ceylon the Assam variety is suited to the plains, a hybrid form is sought for mid-elevations, while the China variety is useful only for the highest elevations up to 6000 and 7000 feet. Mr. Owen recommends that for all new plantations the best "jat" of Assam or hybrid plants should be obtained, as "no amount of care or skill will make up for a bad class of plant put into the garden at the outset." To a beginner in Ceylon, or to a planter in any other country, unacquainted with the particular methods pursued on Ceylon estates, the book would prove at first somewhat perplexing. Too much knowledge is assumed on the part of the reader as regards the important questions involved in the selection of land, while as regards the details of cultivation the particular "fads" and "fancies" of individual planters are too largely dwelt upon. It would have been more to the purpose to present a clear and simple statement of the first principles upon which the growth and culture of the tea plant, as a plant, should be based, in order to produce the best results. As regards the details of the manufacture of tea, quoting authorities is no doubt the best course, for the process of manufacture consists of a series of purely empirical operations, and a statement of principles alone would not meet the case. After discussing selection of land (Chap. I.), varieties of the tea plant (Chap. II.), seed and nurseries (Chap. III.), lining, holing, and planting (Chap. IV.), field cultivation (Chap. V.), topping and pruning (Chap. VI.), plucking (Chap. VII.), and manufacture (Chap. VIII.), the writer devotes the remainder of the book to buildings and machinery (with plans), and to statistical returns connected with yield and cost of production.

The rapid progress made by the tea industry in Ceylon is exemplified by the fact that, while in 1878 only 282 pounds of tea were exported, during the past year (1886) the exports reached over 7,000,000 pounds. The probable exports in 1887 are placed at 12,000,000 pounds, while in 1888 they are expected to reach 30,000,000 pounds. So far, the price of Ceylon tea has maintained a slight advantage over Indian teas—the average price during 1885 being 1*s.* $3\frac{1}{4}$*d.* per pound for Ceylon tea, as against 1*s.* $1\frac{1}{4}$*d.* for Indian teas. The combined effect of large shipments of Indian and Ceylon teas will no doubt lead in time to a displacement of much that now comes from China. And while the general character of tea obtainable in European markets will improve, there obviously must come a fall in prices for which both Indian and Ceylon tea-planters must be fully prepared. At the Colonial and Indian Exhibition, thanks to the energy of Mr. J. L. Shand, Ceylon tea was admirably brought before the English public. Tea from Natal, Fiji, and a small sample from Jamaica were also shown; but the tea from Fiji possessed such special qualities that we shall probably hear more of this promising article.

To return to the subject of this notice, the "Tea-Planter's Manual" is a useful summary of the knowledge gained respecting tea-planting in Ceylon, and it embodies much valuable information for the use of practical planters. What fault there is to be found is not with the book itself, but with the system of cultivation it inculcates—a system which unfortunately appears to be adopted in the treatment of most tropical economic plants by European planters. These plants are treated too purely as so many "rupee-making" machines. Too little attention is given to the characteristics and habits of the plants as living subjects, and too much to the details of an unsympathetic and essentially artificial system, already proved in Ceylon to be unsuited to the coffee plant, but into which there is now a strong tendency to force the

tea plant. As there are diversities of soils and climates, so there are also diversities of industrial plants exactly suited to them. Where all such considerations are ignored, there is danger both to the plants and the planter; and this danger ought in the present case to be avoided. D. M.

GEOMETRY

The Elements of Euclid. Books I.–VI. and part of Books XI. and XII. By H. Deighton. (Cambridge: Deighton, Bell, and Co., 1886.)

Euclid Revised. Book I. with Additional Propositions and Exercises. Edited by R. C. J. Nixon. (Oxford: Clarendon Press, 1886.)

Euclid Revised. Books I. and II. (Same Editor and Publishers.)

First Lessons in Geometry, for the Use of Technical, Middle, and High Schools. By B. Hanumanta Rau. (Madras: Addison and Co., 1885.)

The Origins of Geometry. By Horace Lamb, F.R.S. (Manchester: Cornish, 1886.)

THE author of the first of these books attempts to "give a translation of the Greek text of a somewhat more modern form than the mere verbal ones [what does he mean?] in general use; and, whilst strictly adhering to Euclid's methods, to render his reasoning as clearly and concisely as possible." Hence our presentment of the title-page is supplemented in the original work by the words "newly translated from the Greek text with supplementary propositions, chapters on modern geometry, and numerous exercises." It will be evident that this is Euclid pure and, as far as the author is able to render it, unadulterated; there is no *revision* here such as Mr. Nixon provides for the reader. Mr. Deighton has, however, studied the "Syllabus" (of the A.I.G.T.) and has here and there introduced, with fitting acknowledgment, extracts from it. Further, the author is evidently actuated by the same motives as those which lead the Association to attach so much weight to the solution of geometrical problems as evidence of a student's grasp of the text. A strong feature is the large number of exercises (1419 in all, besides worked out examples), especially of an elementary character, in close proximity to the propositions upon which their solution depends. At the end of the first book are given the enunciations of several propositions which certainly should be mastered by anyone who wishes to gain a sound acquaintance with elementary geometry. Following, it may be, the example of other recent text-books, an excellent collection of the most important propositions on the radical axis, poles and polars, harmonic proportion and centres of similitude are given; there is also a chapter on transversals. The selection of exercises is not confined to Cambridge papers, but levies have been made on the well-known works of Catalan, Rouché, de Comberousse, and Spieker. There are also remarks on plane loci and on the solution of geometrical questions. The letterpress is clear, and the figures are in the main distinctly and carefully drawn, but several monstrosities appear in the third book, as of old, and the drawings on pp. 115, 153, 186 are incorrect as to relative measurements. Perhaps when Mr. Nixon has examined the present book he will modify a statement in his preface (p. vii., we refer to the work reviewed in these columns, vol. xxxiv. p. 50, by R. B. H.) to the effect that "there does not exist a modern edition which gives *Euclid pure and simple.*"

The second and third books are the corresponding portions of the larger work referred to above, reprinted page for page, with the addition of an appendix, in which are given proofs of omitted propositions, and also of i. 5 and of i. 8 as a deduction from i. 7. "This addition is made at the request of several teachers. It is of course a concession to the omnipotent examiner; and, as such, is made with much reluctance." One can only regret that a writer who has taken up so advanced a position should have yielded on this point.

The fourth book is interesting as giving evidence of how a modern movement has taken hold of able mathematical teachers of the mild Hindoo. Mr. Rau candidly repudiates all claim to originality for his matter, as in its compilation he has consulted the best English and French text-books both for pure as well as for practical geometry. "If 'Euclid's Elements' is unsuited for beginners who study it in their own native tongue, how much more so should it be in this country, where it is taught in classes consisting generally of lads between ten and twelve, before they have had time to master the difficulties of a foreign language, and before too, I may add, they can benefit by its rigorous logic. The result, as may be anticipated, has been highly prejudicial to the study of geometry and of mathematics in general. With a view, if possible, to remedy the evil, of which I had become painfully conscious in the course of my several years' experience as a mathematical teacher in schools and colleges, I had long been anxious to attempt a departure from the established route." The work consists of the notes he drew up for the pupil-teachers and students under his charge. "My success in the experiment is my justification for publishing this little volume." The figures are roughly drawn, and the cover is a paper one, but the contents are carefully arranged, and furnish a very fair amount of geometrical information for the class aimed at all the propositions being looked at with an eye to their practical utility. Such a class should know how to hold an object "in an oblique position, not permitting it to retrograde to the perpendicular."

"The Origins of Geometry" is an address delivered at the opening of the Owens College session, October 5, 1886. The Professor of Mathematics casts "a rapid glance over the early history of our science, more especially of that branch of it which was first cultivated with success, geometry." Taking Hankel as his guide, he glances rapidly at matters of which Dr. Allman has treated in much fuller detail; he then treats of what has proved "the most formidable obstacle to the further progress of Greek mathematics, the divorce between geometry on the one hand, and arithmetic and algebra on the other. This had its origin in the discovery of incommensurable magnitudes by Pythagoras and his successors." He, by the way, notes that "the greatest advances in mathematics have been made by men whose interest in the subject was of a speculative kind." The address winds up with the question, "What is likely to be the relation of mathematics to the science of the future?" Prof. Lamb

answers this question only as regards physical science, and his answer is "contained in that to another question, What is the object of the physical sciences?" The whole concludes with words of the late Prof. H. Smith on the function of mathematics in education.

ACOUSTICS

Hand-book of Acoustics. By T. E. Harris, B.Sc., Lecturer on Acoustics at the Tonic Sol-fa College. (London: J. Curwen and Sons.)

A FEW years ago some wiseacre had the temerity to propound the idea that the scientific and historical data on which music is founded have no bearing on music itself, and need form no part of the knowledge to be acquired by a musician. It is quite true that a man may get through life very comfortably as a singer, a fiddler, or a pianoforte-player, without ever having heard of sound-waves or of the Greek modes; but as regards a knowledge of music in a higher sense the idea is absurdly untrue. The moment we approach the *theory* of music we find the scientific and historical elements confront us at every step, and all attempts to form an intelligible explanation of musical structure without reference to them have been, and must be, failures. In fact, no rational theory of music can exist unless founded on such a basis. This fact is now pretty generally acknowledged by those who have to do with musical education. All examining bodies of any weight require an acquaintance with the data referred to, and all well-constituted courses of teaching include them.

The book now before us is a remarkable instance of this. The Tonic Sol-fa movement is what we may call ultra-practical: its supporters aim at teaching music to the great masses of the people, and their system is purposely contrived to facilitate its practical acquirement, and to bring it down to the proverbial "meanest capacity." Yet the Tonic Sol-fa authorities think it right to have a Lecturer on Acoustics, and to publish a hand-book of the science for the use of their millions of pupils. This is certainly about the severest reproof that could be given to the foolish "practical" notion that would exclude intellectual topics from musical study.

There is not much to say about the book itself. It is an unpretending compilation of the most important facts of the science, gathered from various authentic sources, intelligently stated, and without any crotchetiness or affectation of originality. The peculiar feature, of course, is that the musical illustrations are, wherever possible, given in the Tonic Sol-fa notation. Perhaps, in the 286 closely-printed pages, there is more elaboration of detail than the students may care for; but this is to a certain extent counterbalanced by a condensed summary being added at the end of each chapter.

It would have been an advantage if more copious and complete references had been given to other and more original works, from which the matter has been taken. It is, or should be, one of the most important objects of a "hand"-book to enable students, if they desire it, to put more complete treatises on their study-table. There is no date either on the title or in the preface—a very bad habit of music publishers.

OUR BOOK SHELF

Old or New Chemistry: Which is Fittest for Survival? By Samuel Phillips, F.C.S. (London: Wertheimer, Lea, & Co., 1886.)

THIS small book is a collection of essays more or less bearing on the subject indicated by the title, and may perhaps be also described as a sort of protest against a grievance. The elevating and spurring effect of the possession of a grievance is well known, and it must be admitted that in this case it has, apparently at least, contributed to the production of a very entertaining little book, which will no doubt, as it is intended, "wake up" chemists generally to a clear perception of their absurd and useless theories of chemical constitution.

It is, however, doubtful whether the book will really do anything to forward the science of which the author professes to be such an ardent lover. As to Avogadro's law and the laws known as Dulong and Pettit's, however scanty a basis they may have in experimental facts, they have been useful, and will be until they are supplanted by wider-reaching theories. It is exactly here that the author seems to be too conservative. We not only want more facts—as many facts as we can get—but we want theories as well, if they will only again lead to new facts. And, moreover, what is wanted in this country is for chemists to *work*. There is no lack of problems waiting to be solved.

What we do not want is any further multiplication of "fads." Nothing is gained by writing "Ph" for C_6H_5, and the "equivalent symbol" for "etholo-aceto-acetic acid," viz.,

$$\left.\begin{matrix}432\\432\\45\end{matrix}\right\}1294,\ \text{O.HO},$$

at page 19, is no advance but retrogression.

Lectures and Essays. By the late W. K. Clifford, F.R.S. Edited by Leslie Stephen and Frederick Pollock. With an Introduction by F. Pollock. Second Edition. (London: Macmillan and Co., 1886.)

THIS collection of lectures and essays is already so well known that it is now necessary only to note the fact that a second edition has appeared. Two essays have been omitted as being rather mathematical than philosophical, namely, those on "Types of Compound Statement" and on "Instruments used in Measurement." They have found a more fitting place in the volume of "Mathematical Papers" published in 1882. The admirable biographical Introduction by Mr. Pollock has been revised, and some additions and omissions have been made in the extracts there given.

Lives of the Electricians. By William T. Jeans. (London: Whitaker and Co., 1886.)

AN extremely well-compiled and interesting book; but why did the author commence with the life of a living professor, who is not an electrician? Faraday, as the brightest electrical light of this or any other age, should have headed the series. The author has a rich store of names to draw upon—Gilbert, Coulomb, Arago, Snow Harris, Franklin, Cavendish, Galvani, Volta, Henry Davy, Ronalds, Oersted, Ampère, De la Rive, Ohm, Schilling, Gauss, Weber, Daniell, Crosse, Steinheil—without trenching on living celebrities. The work is very impartially written. The life of Morse might have been written by an enthusiastic American, while Wheatstone's friends cannot complain of the eulogy of their hero.

Some statements want revision. The inauguration of the cable system can scarcely be fairly narrated without mention of Messrs. Crampton and Wollaston. Varley's long artificial cable and great experiment shown at the Royal Institution are accredited to Prof. Tyndall (p. 95). The statement attributed to Sir Robert Inglis (p. 285)

that in 1847 England was behind America must surely be wrong. The Electric Telegraph Company in England was then in full swing.

As this is the jubilee year of the telegraph in England, it is well to be reminded that Cooke and Wheatstone made their first practical and successful trial on July 25, 1837, between Euston and Camden, while Morse did not file his *caveat* (*i.e.* did not apply for his patent) until October 5 of the same year.

We wish the book every success, and shall be glad to see further instalments.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Normal School of Science and Royal School of Mines

I AM directed to request that you will be so good as to allow me to state, through the medium of your columns, that the number of applications for admission to the Normal School of Science and Royal School of Mines at South Kensington, at the commencement of the present session, having been considerably in excess of the accommodation which the School can afford, it has become necessary to adopt some process of selection for the future. Hereafter, applications for admission should be sent to the Registrar of the School before the end of May, accompanied by a statement of the studies which the applicant has already pursued, the examinations he has passed, and the name of a teacher (or teachers) to whom reference may be made. Such applications will be considered by the Dean and Council of the School, who will decide on them according to their merits. A knowledge of elementary mathematics, such as is required of all Royal Exhibitioners and national scholars, will be held to be of the first importance for those who desire admission to the course for the Associateship of the School; while for occasional students, who propose only to take up certain specific branches of science, some preliminary knowledge of them will have weight.

J. F. D. DONNELLY

Science and Art Department, January 14

The Cambridge Cholera Fungus

THE letter published by Dr. Klein in your issue of December 23 (p. 171) having incidentally referred to my views as to the nature of the fungus present in choleraic tissue, I should be glad to be allowed to make some further remarks upon the subject.

At an early stage of his investigation Prof. Roy brought for my inspection one of his preparations of intestinal mucous membrane, which clearly demonstrated the presence of certain foreign organisms, and especially drew my attention to a form which he took to be the more usual and typical one. Such a structure might perhaps best be described as consisting of a thin and somewhat moniliform filament which at one end exhibited a distinct nodular swelling. Being struck with a certain (and, as I now fear, a somewhat superficial) morphological resemblance to a group of the Chytridiaceæ, I suggested that the organism might possibly be a Chytridium, and this view was perhaps too confidently adopted by Messrs. Roy and Sherrington in their paper. The appearance of Dr. Klein's letter has naturally led me to carefully reconsider the whole question, and on further consideration I entirely abandon the idea of the organism being a Chytridium. I believe, on the contrary, that it is a Bacterium, and that the structure described by Prof. Roy and seen by myself is that particular phase in the life-history of the Bacterium which is known as an involution form. Such forms are described, for instance, in Zopf's article "Die Spaltpilze," in Schenk's "Encyclopædie der Naturwissenschaften," as *Bacterium aceti* and *Bacterium cyanogenum*. Indeed, the involution form assumed by the latter Bacterium recalls very vividly to my mind the structure shown to me by Prof. Roy.

In conclusion, I may assure Dr. Klein that the fungus is certainly neither a Penicillum nor of the nature of a mould, and that I do not believe it is in any way associated with *post-mortem* change.

WALTER GARDINER

Royal Gardens, Kew, January 11

Snowstorm of January 7, 1887

A MOST extraordinary snowstorm occurred here to-day (January 7). In fifty years' experience I have seen nothing like it, nor has anyone else in this neighbourhood seen any similar phenomenon. It would be impossible to realise the gigantic size of the snowflakes without seeing them. I can only compare them to a fall of oranges, though the diameter of an orange would be small in comparison with thousands of these snowflakes; in this immediate neighbourhood (*i.e.* within sight of the place of observation) at 50 yards off it produced a dense snow-wall. The wind was south, and almost calm, and the largest snow came down nearly perpendicularly. The temperature was 32°·6, and the air completely saturated with moisture. Before the storm the temperature was 34°·1. Snow had been falling with a slight thaw from 10 a.m., the snowflakes being small. Suddenly, at 12h. 12m. p.m. they became $2\frac{1}{2}$ inches in length;[1] at 12h. 14m. they had increased to $2\frac{3}{4}$ inches; and one flake that was caught measured $2\frac{3}{4}$ inches by $2\frac{1}{4}$ inches, and was $\frac{3}{10}$ of an inch thick. At 12h. 16m. the flakes had increased in size to $3\frac{1}{2}$ inches (and several measured were 4 inches across, and there were several larger ones not near enough to be caught); at 12h. 19m. they were somewhat less, and at 12h. 20m. though large, were not gigantic. Fortunately I was measuring and weighing snow at the time, with two assistants, and had a number of flat circular glasses kept cold ready for the purpose of catching crystals, and for measuring the snow that fell upon these glasses. As is usual when very large flakes are falling, there were many of smaller size, though when the flakes were from $2\frac{1}{2}$ to $3\frac{1}{2}$ inches, the majority of the next size were about 2 inches, and the very large flakes would be within 12 inches of each other. A dozen of these large flakes were caught, each on a separate piece of glass, measured and removed under cover, my two assistants giving valuable aid. Of three of these flakes one yielded 14 drops of water, a second 15, and a third 16 drops; and these were not the largest flakes seen.[2] The water from seven flakes weighed a quarter of an ounce within 2 or 3 grains. The weight of ten varied from 13 to 16 grains each; most of the flakes were about a third longer than broad, one flake that was $3\frac{1}{2}$ inches long by $2\frac{1}{2}$ broad was estimated (before it touched the glass) to be $1\frac{1}{2}$ inch thick, when flattened by the force of its descent it was $\frac{1}{4}$ of an inch thick.

The flakes were not a mass of broken pieces, but were composed mainly of perfect crystals, and there must have been hundreds of these crystals in each flake; they were clinging together at every conceivable angle, though a much larger percentage were more horizontal than vertical. A terrestrial radiation thermometer, buried a fifth of an inch within this snow, marked a temperature of 32°·4.

The snow which fell during the last six minutes of this great storm was just under one-fifth of an inch in depth, and yielded ·030 of an inch of water, falling at the rate of 1 inch of water in three hours and twenty minutes (yielding 1 inch of water from 6 inches of snow).

There was a great snowstorm here on December 27, 1886, which varied considerably in places near to each other, *i.e.*—

	Amount of rain and snow	Depth of snow Inches	Melted snow alone
Shirenewton Hall	1·55	7	0·97
Dennil Hill	1·07	5	0·71
Wirewoods Green	0·86	3	0·42
Piercefield Park	0·96	4	—
Chepstow (The Mount)	0·70	—	—

The drifts above here are very great, and a large number of men are still engaged in cutting through them.

The following measurements will show the number of inches

[1] The breadth was less than the length, and the thickness less than the breadth; more or less flattened, and curled over on the edges.

[2] Besides these drops, the wetted glass shall count for two more drops.

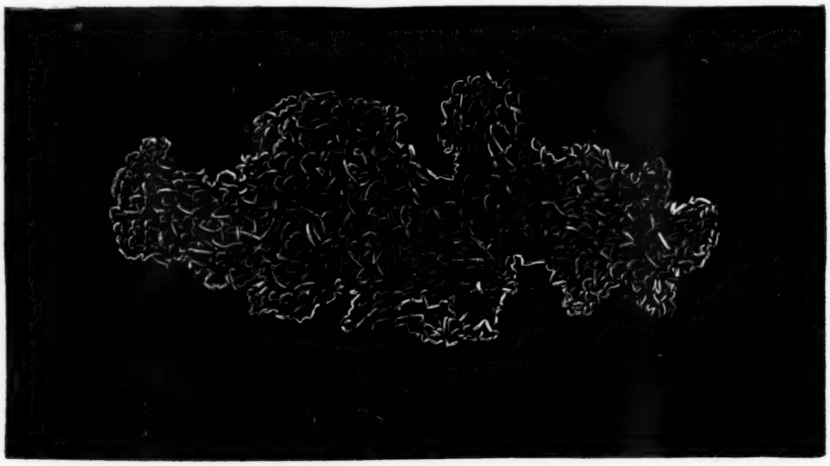
of snow required to yield an inch of water from observations taken here:—

1886, January 23, snow 2 inches, melted ·063 (*i.e.* 33 inches for 1 inch of water); March 1, snow 7 inches, melted ·800 (*i.e.* 9 inches for 1 inch of water); December 26, snow 7 inches, melted ·967 (*i.e.* 7 inches for 1 inch of water). 1887, January 4, snow 3¼ inches, melted ·379 (*i.e.* 8½ inches for 1 inch of water); January 7, ⅙ inch, melted ·030 (*i.e.* 6 inches for 1 inch of water).

The damage done on December 26 was unusually great, the snow being very heavy, as much as 5 lbs. weight on a square foot of a cedar-branch; this, when moved by the wind, caused much breakage.

January 8.—Since sending my note yesterday I find that at Chepstow and at Itton the snowflakes were larger than anyone had before seen, so that probably the storm had an extended area; at all events it was 5 miles broad.

The present storm is a very similar one to that recorded by myself in January 1838, except that the largest flakes in 1838 did not exceed 2 inches. In that storm the largest flakes fell more rapidly and more perpendicularly. I then pointed out that large snowflakes were produced by two upper currents driving the flakes together; and afterwards, by the largest falling with increased velocity and more perpendicularly: they were thus able still more to augment their dimensions by adding smaller ones to their bulk. This was well seen on January 7, when an estimate was made as to the velocity and angle of their descent. Not only were a number seen to be added as they fell upon them, but it was thought that small flakes when near to the large ones were attracted to them. The flakes were, however, large whilst at a considerable distance from the ground.



Shape and size of snowflake. (There were more of a somewhat similar form to this than the more circular ones, though there were very many more circular and less indented.)

Several flakes were sketched before they began to melt, and one of the sketches is sent as an illustration. The glasses were at a temperature of freezing, and therefore it was some time before the snow melted, and not thoroughly so until they had been 5 minutes in a hot-house.

January 13.—The snowflakes folded over on the edges, boat-like, and this curling over caused the thick look observed. There was a slight zigzag in their downward course of some 2° or 3°. This storm passed over Chepstow, Itton, and Monmouth in this county; Wirewoods Green, Tidenham, and Dennil Hill, all in Gloucestershire, and Bath: in all of these places the flakes are spoken of as the largest ever seen. One correspondent at Chepstow reports them as larger than the hailstones in the storm of May 1848, which were larger than hens' eggs, and broke the shop windows, and destroyed the glass of hot-houses near Chepstow. E. J. LOWE

Shirenewton Hall, near Chepstow

Auroras

THE account, in NATURE for December 16 (p. 159), of a bright cloud "emitting brilliant rays of light," that suddenly appeared at Hamar, in Norway, on the night of November 3, recalls the fact that on November 2 there was at Lyons, New York, an aurora which at one time during the evening consisted entirely of detached luminous clouds, as was noted in NATURE for November 18 (p. 54). It is stated that on November 4 one of the finest auroras of the year was visible at Throndhjem, Norway. M. A. VEEDER

Lyons, N.Y., January 3

A Solar Halo

IN the weather report issued on Friday evening, the 14th inst., a solar halo is recorded as "observed in Jersey during the day." Between noon and 12.30 I observed a very complete and well-defined halo, of radius about $\pi/8$, in this neighbourhood. It was not perceptibly tinted, but the duskiness of the interior, as compared with the clear sky exterior to the luminous ring, was more pronounced than I ever remember to have noticed it on other occasions—so much as to suggest comparison with the "curtain" of the aurora: "Solem quis dicere falsum audeat!" J. J. WALKER

Hampstead, N.W., January 15

THE NATIONAL SCIENCE COLLECTIONS[1]

II.

25. REVERTING to this country, the "Patent Museum," now under the charge of the Science and Art Department, is a collection of a peculiar nature; and in order to explain its origin, and the objects it was intended to serve, we may make some extracts from the Report of a Select Committee of the House of Commons, appointed in 1864, to inquire as to the most suitable arrangements to be made respecting the Patent Office, Library, and Museum. The Committee said:—

The second point to which your Committee directed their attention was that of the Patent Museum, having regard especially to its formation, its present state, its relation to the Patent Office and Library, and the nature of its contents, so as to render it practically useful.

Your Committee found that the Patent Museum was formed by Mr. Woodcroft, the Superintendent of Specifications, by the request of the Commissioners of Patents, and that it consists of models and machines belonging partly to the Commissioners of Patents, partly to the Commissioners of the Exhibition of 1851, and partly to Mr. Woodcroft himself, and various private persons.

[1] Continued from p. 254.

This collection has been exhibited since 1857 in the iron building at South Kensington.

Your Committee are of opinion that the term Patent Museum (which is generally applied to this collection) tends to give an erroneous impression as to its character and object.

Various suggestions have been made by witnesses respecting the nature of a Museum connected with the mechanical arts, which may be summed up as follows:—

(*a*) That it should illustrate the history of those arts by a collection of original machines from an early period to the present time.

(*b*) That it should exhibit all known inventions respecting machinery and manufactures.

(*c*) That it should show the present state of all machinery and manufactures.

(*d*) Some of the witnesses suggested that the collection should be restricted to the machinery and manufactures of the United Kingdom; whilst others proposed that it should be extended to those of foreign countries.

(*e*) Some, again, proposed that the collection should contain all the objects of each class, whilst others proposed that a selection only of the most important objects should be exhibited.

(*f*) There was no less diversity of opinion respecting the primary purpose for which any collection or exhibition should be made; some of the witnesses considered that it should be for the purpose of conveying instruction in the mechanical arts, either in a cursory way to people who might visit the Museum, or to students in mechanics, or to persons desirous of applying themselves to the discovery of improvements in machinery and manufactures.

(*g*) Other witnesses deemed the Museum chiefly desirable for the information of persons intending to take out or purchase patents, in aid of the information afforded by books and specifications, to assist them in ascertaining whether the contemplated patent would be valid as a new invention.

(*h*) On the other hand, two witnesses, Mr. Carpmael and Mr. Johnson, gave it as their opinion that for all purposes of the patent law a museum of models would be practically valueless.

Your Committee are of opinion that any special collection of patented inventions made for the purpose of evidence, illustration, or record of patent rights is not so connected with a general museum of mechanical inventions as to render the neighbourhood of such a museum to a patent office and library, or law courts, necessary.

It appears to your Committee that the chief purpose of a general museum is to illustrate and explain the commencement, progress, and present position of the most important branches of mechanical invention; to show the chief steps by which the most remarkable machines have reached their present degree of excellence; to convey interesting and useful information, and to stimulate invention.

In forming an illustrative collection of inventions it would be necessary to adopt the principle of selection. This, however, does not appear to your Committee to be an insuperable objection, especially as no one proposed to substitute models for specifications, which for all the purposes of administering the patent law would still have to be consulted, and bear the stamp of authority.

Such a collection should contain a selection of models of moderate size, which should illustrate different departments of inventions, and also a selection of models of current patented inventions.

The Patent Collection, although it was placed in premises belonging to the South Kensington Museum, remained in the hands of the Commissioners of Patents until January 1, 1884, when, by the "Patents, Designs, and Trade Marks Act, 1883," 46 and 47 Vict. c. 57, it was transferred to the Science and Art Department.

The title "Patent Museum" was never accurate; the collection might with greater propriety have been called the "Woodcroft Museum," from the name of the gentleman, formerly Clerk to the Commissioners of Patents, who originated the formation of it. It contains objects illustrating steps in the history of mechanical inventions, and contrivances of importance and interest, without regard to whether they have been patented or not. Among these, for example, are the earliest locomotive and stationary steam-engines; the first engine used in steam navigation; the first reaping-machine; Arkwright's original spinning-machinery; all Sir Charles Wheatstone's original apparatus, showing a complete history of the various steps by which he perfected electric telegraphy; many of Edison's original electrical inventions; some old clocks dating from 1325; and other objects of similar interest.

Inventions embodied in future patents may be added to this Museum, pursuant to Sections 41 and 42 of the Patent Act above mentioned. These sections enact as follows:—

(41) The control and management of the existing Patent Museum and its contents shall, from and after the commencement of this Act, be transferred to, and vested in, the Department of Science and Art, subject to such directions as Her Majesty in Council may see fit to give.

(42) The Department of Science and Art may at any time require a patentee to furnish them with a model of his invention, on payment to the patentee of the cost of the manufacture of the model; the amount to be settled in case of dispute by the Board of Trade.

We do not consider it to be feasible to combine a complete museum of patented inventions with a methodical collection of objects illustrating practical science, and we infer from the language of Parliament in the provisions just quoted that this is the view taken in the recent Patent Act, which enables, but does not oblige, the Department of Science and Art to acquire specimens of patented inventions.

26. We conceive that it will be useful for the curators of all the collections to bear in mind that their primary and indispensable scope is to provide apparatus and specimens for the instruction given in the Normal College of Science, and for the teaching of science generally throughout the United Kingdom.

Cases may doubtless arise where the acquisition or reception of other objects may be expedient, in the interest of science or of the arts; but in these cases, in order to prevent the unnecessary occupation of space, we recommend that due regard be had to existing public collections elsewhere, so as not unnecessarily to duplicate the provision for illustrating science.

27. Referring now to the space required, we adopt the following figures given by the Reports of the different Committees, adding some estimates for the future where they have not been stated:—

	Space now required	Estimated increase of space required in ten years	Space required at the end of ten years
	Sq. ft.	Sq. ft.	Sq. ft.
Various science collections	37,000	3,000	40,000
Naval models	10,500	10,000	20,500
Building construction	15,000	10,000	25,000
Fish culture	5,000	1,000	6,000
Educational collection and library	7,500	1,000	8,500
Mechanical collections...	45,000	15,000	60,000
	120,000	40,000	160,000

In framing their estimates, the Committees generally took, as the basis of their computation, top-lighted galleries 30 feet wide, which afford a large amount of well-

lighted wall-space in proportion to floor-area. But with galleries side-lighted, in which some part of the collections must necessarily be housed, an increase of floor-area will be required.

28. In adopting these estimates, we think an indefinite series of demands for accommodation, involving an indefinite extension of space, ought not to be contemplated. The pleas commonly put forward for such extension at the close of every Exhibition are the number of articles which are either offered as gifts or are said to merit acquisition. We think that merit alone should be the ground of admission, and that even this ground must be subject, in the first place, to the consideration of space, and next, to that of scientific arrangement. If space is to be in any degree limited, and scientific arrangement to be maintained, it is evident that exclusion and depletion, as well as completion, must be kept in view; and that while the Department of Science and Art is left all possible freedom in determining what the contents of its collections shall be, it should be strictly confined to the area which is represented to be sufficient for the future.

In the due appropriation of this area we do not consider that, as a rule, and except in cases of historic interest, engines and machines of the original size should be acquired, or even accepted on terms implying that they will continue to be exhibited otherwise than in models.

29. Comparing now the estimates of space required with the area at present available, we find as follows:—

The total available floor-space in the present buildings, assuming the Western Gallery, D, to be given up, and the building E to be abolished, is 51,500 square feet.

This is 17,480 feet less than the collections at present occupy, and less than half what the Committees estimate for them when fairly completed.

It is clear, therefore, that new buildings are absolutely required.

Provisions for Housing the Collections

30. The second duty confided to us is:—

To suggest plans for housing the collections in the existing galleries to the south of the Horticultural Gardens, or in new galleries to be built upon their site, and the adjacent ground now the property of the Government.

31. In considering this matter, we have had the valuable assistance of Mr. Taylor, the Surveyor to Her Majesty's Office of Works, who has, in accordance with our suggestions, carefully examined the existing buildings, and prepared sketch-plans and estimates to meet the circumstances of the case.

32. We have already referred to the land available. It is shown on the Drawing No. I., marked G, and coloured red, and it consists of a plot of ground to the south of the South Galleries A, B, C, containing 4 acres and 23 square yards.

This land, as well as the site and ground of the Natural History Museum to the south of it, was purchased by the Government, in 1864, from the Commissioners of the Exhibition of 1851, and the particulars of the transaction are fully set forth in the Fifth Report of the Commissioners, dated August 15, 1867.

33. In this Report (p. 31) the Commissioners say:—

"We have set forth in detail all the circumstances connected with the sale by us to Her Majesty's Government of the site of the Exhibition of 1862, with the sanction of Parliament, and under the special condition that the site in question shall be permanently devoted to purposes connected with Science or the Arts."

This condition is fully and strongly carried into effect in the deed of conveyance, which is published as an Appendix to the same Report; so that the appropriation of this land for the erection of a Science Museum is in strict compliance with the conditions of its acquisition.

34. The buildings forming the southern range A', A, C, B, B', although not of first-rate character, will yet last in good order for many years to come, as will also the Western Gallery D.

We are, however, of opinion that a plan should be prepared to include the eventual reconstruction of the whole southern range.

But it should be a plan capable of being carried out by degrees, as and when necessity demands.

35. Drawing No. II. shows a ground plan of a design which fulfils these conditions.

It provides for two three-storied buildings of ornamental elevation, forming frontages (with returns) to Exhibition Road on the east, and to Queen's Gate on the west; and for plain two-storied buildings adjacent to these east and west frontages. These buildings, together with the existing southern buildings (A, B, C) will afford the required space until the latter become unserviceable, and permanent structures have to be erected on their site.

These buildings would give room for the collections, with the necessary offices, for the Portrait Gallery, and, if desirable, for examination-rooms.

Measures Recommended

36. The measures we recommend are as follows:—

Section I.—*Alteration of Arrangements in the existing Galleries*

(*a*) Remove the collection from the upper floor of the Western Gallery, D, and place it temporarily on the lower floor of the same building, and in A, B, or C.

(*b*) Remove the Portrait Gallery into the upper floor of the Western Gallery, D; this floor has been used during former Exhibitions as a Picture Gallery, and has given great satisfaction to the artists. This gallery, as it exists, is more secure against accidents by fire than the building in which the pictures are now placed, and can be rendered, at a moderate outlay, practically incombustible.

(*c*) Clear out the ground floor of the Western Gallery, D.

(*d*) Then use this ground floor for examination-rooms. When this is done, the entire Western Gallery, D, will be occupied, and none of it will be further available for the collections.

(*e*) Make an opening through the wall which now shuts off the centre building, C, so as to give an approach from Exhibition Road to the western parts of the galleries, and thus do away with the unsightly gallery K.

(*f*) Proceed to arrange the rooms as they are set free.

(*g*) In addition to the access from Queen's Gate to the portrait gallery in D, afford access to it from Exhibition Road through the Science collections.

Section II.—*New Works to be undertaken*

37. The proposed new building is so designed that it may be carried out in separate portions progressively.

The portion to be first undertaken should be on the parts marked L and L[1], with the temporary entrances, all coloured yellow on the drawing No. II. These buildings may be completed in about eighteen months, and are estimated to cost about 43,520*l.*, which may be distributed over the financial years 1886-87, and 1887-88.

Before the end of 1887, also, the option must be exercised of purchasing the central building, C.

When the above-mentioned first portions of the new building are completed, they will add an available area of 28,700 square feet, which, with the areas already existing in the southern galleries, will make a total of 80,200 square feet.

This will provide, for the Science collections, about 11,000 feet more than they at present occupy, and it will admit of the Patent Museum being removed to the western side of Exhibition Road, and of the building E

being abandoned. At the same time the temporary appropriation of the Western Gallery, D, to the Portrait Gallery and the examination-rooms, will give them an advantageous increase of accommodation. Hence, by this first instalment of the new works, a considerable improvement on the present state of things will be effected; but the space will still be much below what has been estimated as necessary by the Committees who have investigated the matter.

38. The next portion to be undertaken may be the building with façades at the eastern end, marked M¹ on the drawing, and coloured red. This is estimated to cost 54,183*l.*, and it will furnish 33,750 square feet of additional floor-space.

When this is built there will be, in all, 113,750 square feet available, *i.e.* enough not only to accommodate the present collections, with some increase, but also to receive the Portrait Gallery, and to provide examination-rooms, if required.

At this time, therefore, there will no longer be any need to hire from the Commissioners of 1851 the Western Gallery, D, and thus an expenditure of 2000*l.* per annum will be saved.

39. The accommodation can afterwards be extended from time to time, as and when means may be voted for the purpose, by the erection of the other portions shown on Drawing No. II., as follows:—

	Additional space obtained Square feet	Estimated cost £
Interior building at the east end, marked N¹, and coloured brown	28,350	32,930
Building with façades at the western end, marked M, and coloured red	37,950	59,240
Interior building at the west end, marked N, and coloured brown	28,350	32,930

40. The entire floor-space gained by the new buildings, when completed according to Drawing No. II., will be 157,100 square feet. To this must be added the space in the existing southern galleries, which will be assumed still to remain available. They contain, at present (as we have already stated), 51,500 square feet; but, in the process of building the new erections, a portion of the old ones will have become absorbed therein, and the space will be reduced to 41,818 square feet. The total available space will therefore amount to 198,918 square feet.

The total estimated cost of the new work shown on Drawing No. II. is 222,803*l.*

41. In submitting this Report to the Treasury, we desire to state to their Lordships that one of the principal considerations guiding us has been to prepare a plan which admitted of being executed in parts, but which, when completed, should suffice for as long a period as we think it necessary to foresee. We have taken as our starting-point the demand of 160,000 square feet of area, and we have shown how it may be provided without more than a strictly temporary use of the Western Gallery, which does not belong to the Government.

42. We have been invited to express an opinion as to whether there would be space, in the completed plans, to provide for the collections now housed in the Museum in Jermyn Street, and the instruction now given there. We believe that there would be space for the purpose.

We have the honour to be, Sir,

Your obedient Servants,

FREDERICK BRAMWELL
LINGEN
J. F. D. DONNELLY

WILLIAM POLE,
Secretary,
Westminster, July 27, 1885

P.S.—Mr. Mitford dissents, for the reasons appearing in a separate Report handed in by him on the 4th ultimo, which, with other documents relative to it, is inclosed in the letter covering our Report.—F. B.; L.; J. F. D. D.

TRANSMISSION OF POWER BY COMPRESSED AIR

A MOST interesting experiment is about to be tried in Birmingham. A Company, whose engineer is Mr. J. Sturgeon, has obtained Parliamentary powers to supply power from a central station by compressed air through pipes laid in the streets. The application to Parliament was supported by the Birmingham Corporation, and the powers extend over an area of between four and five square miles. It is at first intended to restrict operations to about one square mile and a half. This area will include twenty-three miles of main pipes. The central works are designed for the production of 15,000 horse-power, of which the engines laid down at first will supply 6000 horse-power. The authorised capital expenditure for the whole is 276,800*l.*, of which 150,000*l.* will be spent at once for the initial 6000 horse-power. In this journal we have nothing to do with the financial aspects of the project, but we mention these figures to show that within a short time the system may be expected to be in operation on such a scale as will very fairly test its mechanical efficiency. At a recent meeting of the directors it was determined to start clearing the ground and commencing the foundations for the central station at once, so that by next summer we may see considerable advance made towards the realisation of the project.

This is the first time that an experiment of this kind has been tried in Britain. Power is distributed from a central station at Hull by the hydraulic system, but transmission by air has hitherto only been tried in small installations at mines, quarries, in sinking piers, as at the Forth Bridge, and in tunnel-boring. In mines and tunnels it has very evident advantages, in that it keeps up a continual supply of fresh, cold air where ventilation is very much needed; and therefore its undoubted success at the St. Gothard works does not demonstrate its certainty of success for the distribution of power on a large scale to the workshops of a town where the atmosphere is bearably pure. Moreover, the pipe systems of these small installations have not been sufficiently long and complicated to test in any severe sense the liability to loss by friction, leakage, and variation of temperature.

The results of the present experiment will therefore be of the utmost scientific value to engineers, and will be watched with corresponding interest. No fairer field for such an experiment could be found than in Birmingham, which is marked out from all other towns by the enormous number of its small workshops requiring minute amounts of driving-power, and the total turn-over of each of which is too small to enable the owner to afford skilled tendance to his boiler and engine. In these small shops the power is required only intermittently throughout the day. At times the engine may actually stand altogether for an hour or two, while it is only rarely that it is called to exert more than a comparatively small fraction of its full power. Meanwhile the large loss due to furnace and boiler inefficiency—that is, to waste of heat by radiation and by hot gases passing up the chimney—goes on steadily at a pretty uniform rate. Under such circumstances, the advantages of generating the power at a great central station are so evident as not to require demonstration. The question of chief technical interest is really as to whether the best means of distribution is by air, by water, by electricity, or by cheap gas to be used in gas-engines. That question can only be finally settled by expensive experiment. In passing, the writer may indicate his own opinion that there lies in the future a magnificent field for enterprise on the part of the gas companies of large towns in supplying cheap gas for heating and the production of mechanical power, and it is most decidedly their interest to improve the efficiency and lower the prime cost of gas-engines.

The site of the central works is a triangular plot of ground adjoining Garrison Lane, at the intersection of the

London and North-Western and the Midland Railways. The Birmingham and Warwick Canal forms one boundary of this plot. The fuel to be used under the boilers is gas obtained from Wilson's eight-hundredweight producers. Eighteen of Lane's water-tube boilers will supply six engines to produce the 6000 horse-power aimed at at first Air is admitted to the furnaces through gridiron sliding shutters, by means of which the supply is hand-regulated. It mixes with the gas in a mixing-chamber immediately below the front end of the furnace. The roof of this mixing-chamber is an arch of perforated bricks, and these bricks becoming highly heated the mixed air and gas is raised to a high temperature before being ignited. No special means have so far been considered necessary to prevent risk of lighting back into the mixing-chamber. The production of gas in the producers is controlled by the steam jet blown in at the foot of each. The steam for these jets is supplied from a special donkey boiler. The whole of the steam jets are throttled down by the action of a governor that runs, so to speak, in equilibrium with the air-pressure in the mains. The engine drives a small air-pump, which forces air into one end of a small cylinder, to the other end of which the air from the mains is admitted. If the pressure rises in the mains above standard, the piston of this cylinder is moved, and this movement is communicated by suitable gearing to the throttle-valve regulating the steam jet to the producers. The production of gas, and therefore the production of heat by its combustion under the boilers, are thus automatically regulated in accordance with the requirements, so that the air-pressure in the mains is prevented from varying outside certain narrow limits. In connection with this part of the scheme we may point out that it seems to be a mistake not to throttle the entrance-areas for the air to the furnaces automatically and simultaneously with the regulation of the gas supply. The chief advantage in using gas instead of solid fuel lies certainly in the power of obtaining perfect combustion by thorough admixture and careful proportioning of air to fuel. This advantage is sacrificed if the air supply is not diminished and increased simultaneously with, and in the same proportion as, that of gas. We suspect also that it will be found desirable not to rely solely on the throttling of the steam blast as at present intended; the more direct and rapid action of a throttle-valve between the producer and the boiler-furnace will be highly advantageous, if not necessary. By means of simple mechanical relays, actuated either by the steam or by the compressed air, there can be no difficulty in controlling these three sets of throttle-valves by the action of a single governor.

The steam-pressure is to be 160 pounds per square inch. Each set of three boilers supplies an engine of 1000 horse-power. The engine is of the triple-expansion type; the high-, intermediate-, and low-pressure cylinders having the diameters 20, 30, and 49 inches, and a common stroke of 48 inches. The areas of the three pistons are thus in the ratios 1, $2\frac{1}{4}$, and 6. The cranks are at 120° to each other. The high-pressure and intermediate cylinders are steam-jacketed at the sides. The low-pressure cylinder is not jacketed, but a novel arrangement of steam-jacketing its piston is adopted. The piston is hollow, and steam is led into its interior by a tube which is parallel to the piston-rod, and moves to and fro through a stuffing gland in the cylinder cover, projecting into a larger tube screwed on the gland and supplied with steam direct from the boiler. The argument in favour of this arrangement is that side-jacketing of the low-pressure cylinder involves a large absolute waste of heat that goes towards heating the exhaust-steam as it leaves the cylinder on its way to the condenser; this loss of heat by the jacket steam being noxious, not only because it is pure waste, but also because it raises the back pressure against the piston. The fresh steam in the hollow piston sweeps over the inside surface of the cylinder just in front of the incoming working steam, and thus heats the metal and prevents undue condensation of the working steam, while it is comparatively inactive in heating the back-pressure steam. In criticism of this argument, it may be remarked that towards the end of the stroke (during the last quarter of the stroke) this piston-jacket surface giving heat to the exhaust-steam is greater than a side-jacket would offer. For three-quarters of the stroke, however, it is less.

Each cylinder is connected with the fly-wheel shaft by a cross-beam. Over each end of each beam stands a single-acting, air-compressing cylinder of 26 inches diameter and 48-inch stroke. Each engine thus drives six of these air-pumps; and, since the speed is ninety double strokes per minute, the volumetric capacity of the compressors of each engine is close on 8000 cubic feet per minute.

The pressure in the mains is to be 45 pounds per square inch above the atmosphere, and the delivery-valves are expected to lift a little before three-quarters of the compressor piston-stroke is finished. Thus the volume of air compressed to the above pressure delivered per minute by each engine is taken as about 2000 cubic feet.

The ratio of pressures is $\frac{59 \cdot 7}{14 \cdot 7} = 4 \cdot 06$. Thus, if the compression curve were isothermal, the valves would lift, as above assumed, at ·75 of the stroke. If it were adiabatic, this pressure ratio would correspond to a ratio of final to initial volume of ·367, and the valves would lift at ·63 of the stroke. If the curve lay exactly mid-way between these two, or were according to the law $p \propto v^{-1 \cdot 2}$, the ratio of final to initial volume would be ·31, and the valves would lift at ·69 of the stroke. In the latter case the volume delivered would be $\cdot 31 \times 8000 = 2480$ cubic feet per minute. Calculating simply from the product of this volume by 45 pounds per square inch pressure (*i.e.* from the work the air could do in an air-engine without clearance, without expansion, and without more than atmospheric back pressure), this would give about 487 horse-power delivered in the consumer's engines for each engine developing 1000 horse-power at the central station. Two indicator-cards taken from two air-compressing cylinders at Frood Colliery, near Wrexham, give very different results, possibly because one compressor was near the steam-engine cylinder, and was heated by it, while the other was not. The compression-curve from the one cylinder corresponds with the relation $p \propto v^{-1 \cdot 237}$, while that from the other corresponds to $p \propto v^{-1 \cdot 66}$. The latter curve is thus much steeper even than the adiabatic, and would indicate that the air was actually heated by conduction or radiation during its compression. Such heating could hardly have taken place to such an extent as to account for the above very high index, and the more probable explanation is that the air was steam-laden as it was taken in, and that the extra rise of pressure is really due to that of the steam in the mixture consequent on the rise of the temperature.

It is desirable to keep down the compression-curve as nearly as possible to the isothermal line, because by doing so the area of the compressor indicator-card, and therefore the work to be done by the engines, is kept down to its minimum; whereas no advantage can be derived from the increase of temperature obtained by adiabatic compression, because this is rapidly lost by cooling in the pipes long before the air is utilised in the air-engine it drives. It is worth noticing that, because of the air being discharged from the compressors through valves which *automatically* lift when a certain designed pressure is reached, this loss of power due to cooling in the pipes is effected rather by a contraction of *volume* than by a diminution of *pressure*. The decreasing-pressure gradient along the pipes is very small, and is due solely to frictional and viscous resistance to the flow, and to variation of velocity consequent on variation of section.

In order to approximate to isothermal compression,

Mr. Sturgeon has adopted very special cooling arrangements for his compressors. Firstly, the air used is all taken through the roof of the engine-house, and thus heating by contact with the boilers and engines below is avoided. It is filtered of deleterious dirt in entering through the roof. Secondly, the compressor cylinders are surrounded by ample water jackets, through which a continual fresh-water circulation is kept up. Thirdly, the delivery-valve—it is a single large disk of slightly greater diameter than the cylinder—is made hollow, and through it a cold-water circulation is kept up, the water being spread out in a thin radial stream across the valve face over which the air flows as it leaves the cylinder. This cooling-water is supplied to the hollow valve through a tube sliding in a stuffing-box in the cylinder cover. A further development of this system would be a supply of cooling water to the face of the piston after the manner that the steam is supplied to the piston-jacket of the low-pressure engine cylinder; but this refinement has not been deemed necessary in the design as at present adopted.

The compressor piston-face travels a little beyond the position assumed by the flat face of this delivery-valve when the latter is closed. During the momentary pause at the end of the stroke, the valve therefore falls into actual contact with the piston-face, and the two descend together until the valve is landed on its seat. Thus the clearance space is reduced absolutely to zero.

The suction-valves are somewhat similarly arranged so as to reduce the clearance at the other end of the stroke to a very small amount. The cooling-water is circulated by gravity from a tank giving a head of 20 feet. The water is pumped into this tank from the canal, and the power spent in pumping this water is a partial set-off

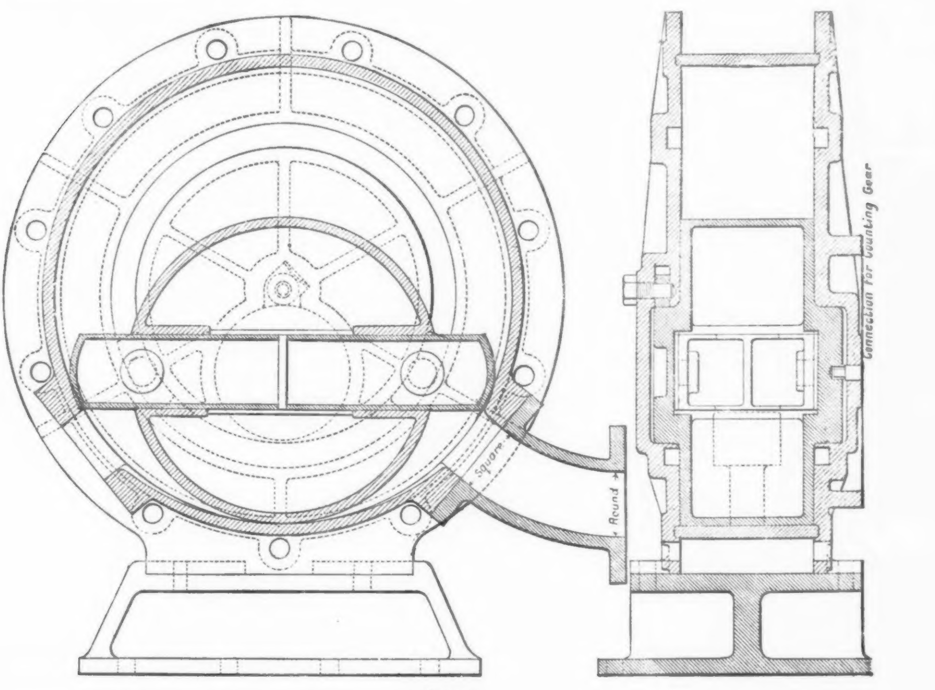


FIG. 1.

against the economy resulting from the approximation to isothermal compression; but the power thus gained greatly outweighs the work spent in this pumping.

As at present designed, the air-pipes are of wrought-iron plate, riveted, but a new design for plate-steel tubes is being considered. The pipes are to be laid in concrete tunnels, which free them from all pressure of superincumbent soil or paving, and will always be very accessible for examination and repair. They are of 24 inches diameter near the central station, and diminish to 7 inches in the smallest branches. The joints are given a small degree of flexibility. In one design they are formed by two angle-irons riveted to the outside ends of the two pipes, a hard rubber ring of circular section being placed between the flanges thus formed, and the flanges being drawn together by bolts. In another design a sort of double-socket coupling-piece covers the ends of both pipes for a few inches; the end of each pipe has formed on it two slightly projecting rings, and between these is poured, in the molten state, through a hole in the socket-coupling, a soft metal that expands during solidification. We rather doubt whether this last design will give sufficient tensive strength to the joint. Tensive strength is required simply because there are necessarily bends in the pipe here and there.

The air is supplied to the consumer through a registering meter. This meter is similar in construction to Beale's gas exhauster. It consists of two cylinders, one inside the other. Both are 4 inches long; the outer one has a diameter of 14 and the inner a diameter of $9\frac{3}{8}$ inches. The outer one is fixed, and is furnished with an inlet and an outlet opening. The inner cylinder revolves freely on a fixed axis, distant $\frac{1}{2}(14 - 9\frac{3}{8}) = 2\frac{5}{16}$ inches away from the centre of the outer case, so that the two cylinders always touch along a fixed line. Two sliding shutters project from a slot through the centre of the revolving

cylinder. By means of a pin and a pair of sliding blocks running in circular grooves cut on the inner surface of, and concentric with, the fixed cylinder, these shutters are drawn out and in from the revolving cylinder so as always to keep in contact with the fixed one. During one revolution these shutters sweep through the meter a volume of air about ·17 cubic feet.

This rotation is reduced three times by worm-gearing in being transmitted to the counter-box, so that a single dial with two concentric circular scales, which are read by two fingers like the hour- and minute-hands of a common clock, is sufficient to register up to a million cubic feet. Fig. 1 shows this meter. It is driven by a small difference of air-pressure between the inlet and outlet.

The Company intend to charge at the rate of 5*d.* per 1000 cubic feet at standard pressure of 45 pounds per square inch. If the air were used in an engine without expansion, without clearance space, and without back pressure above the atmosphere, this would correspond to a cost per hour per indicated horse-power of

$$\frac{60 \times 33000 \times 5}{144 \times 45 \times 1000} = 1{\cdot}53 \text{ pence.}$$

Under the conditions of actual practice the writer calculates that at the above rate of 5*d.* per 1000 cubic feet, assuming intelligent and economical management, each

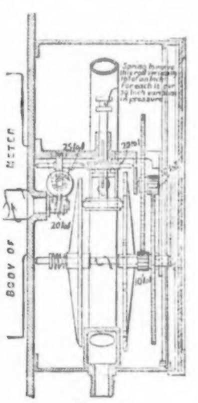


FIG. 2.

indicated horse-power will cost per hour from 2*d.* down to as low as $1\frac{1}{2}d.$, excluding cost of engine attendance and depreciation, and interest on first cost of engine.

The standard pressure at which the air is sold at the above price being 45 pounds per square inch, a reduction of price per cubic foot has to be made if the pressure of the supply be less than this pressure. This is effected by introducing a variable velocity-gear between the volume-meter and the dial-counter. This arrangement is shown in Fig. 2.

The rotation is transmitted to a small roller on a spindle capable of sliding in its bearings parallelly to its own axis. It drives a disk on the counter-arbour by rolling contact. The end of the roller-spindle is linked to the end of the tube of a Bourdon pressure-gauge. As the pressure rises, the roller is thus pushed nearer the centre of the disk, and gives this disk, therefore, an increasing fraction of a revolution per revolution of the roller. The roller really lies between two disks, but the one is "idle" and serves simply to support the roller in pressing against the driven disk.

This integrator is wholly wrong in principle, and it is badly designed in detail. The roller has a rubber tyre round it, and therefore touches the disk at different radii, and thus must rapidly wear away, owing to the want of pure rolling action at one or other side of its tread. The wearing might not be of much consequence in itself, except that it gradually vitiates the accuracy of the indication; and besides, the velocity ratio is uncertain because of the contact taking place over a perceptible range of radius. There ought to be an idle roller between the disks opposite the driving roller, and both disks ought to be pressed inwards by springs, instead of one only. But the chief defect is in the principle of the construction, which does not make the dial-indication proportional to PV as it ought to do. If R_0 be the disk radius at which the roller would stand when zero pressure existed in the Bourdon tube, and if C be the inward movement per pound per square inch rise of pressure, and if r be the radius of the roller, then at pressure P the contact radius on the disk will be $R_0 - CP$, and the fractional revolution of the disk per revolution of the roller is $\frac{r}{R_0 - CP}$. This is not proportional to P as it ought to be. Its differential coefficient with respect to P should be constant, whereas it is really $-\frac{Cr}{(R_0 - CP)^2}$. The converse gearing ought to be substituted; that is, the volume-meter should be geared positively with the disk, and the disk should drive

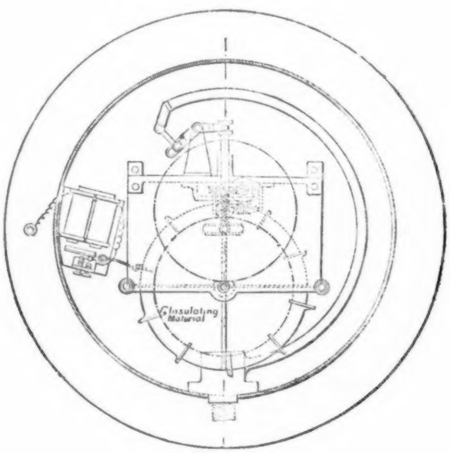


FIG. 3.

the roller, the point of contact for zero pressure coinciding with the centre of the disk. It also seems a pity, when a Bourdon tube that measures the pressure exists in any case in the meter, that its measurement of the pressure should not be made visible by the simple addition of a pointer and graduated dial.

The registrations of all the meters in the whole district are telegraphed to the central station and added up on one large central counter, so that the engineers in charge may have means of continually comparing the actual consumption with the duty of the engines, known from ordinary engine continuous counters, and of detecting any serious leakage that might occur in consequence of breakage of a main or branch pipe. The telegraphing apparatus is shown in Fig. 3. The counting disk is divided into ten equal divisions, each representing 1000 cubic feet, by small metal projections. As these come successively underneath a contact-maker, they allow the passage of a current, which moves the finger of the central counter through a corresponding division. One main wire, with branches to the separate meters, is sufficient for the whole district, the earth return being used. As the counter-disk moves slowly, special means must be taken to break the

contact instantaneously after it is made; otherwise all but one of the indications of several meters, whose times of contact with the tooth on the disk overlapped, would fail to be registered at the central station, and should the stoppage of any one engine in the district happen to occur while this tooth of its meter was in contact the whole registering apparatus would cease to act for an indefinite time.

The contact-breaker is shown in Fig. 3, at the left-hand side. The momentary current caused on making contact magnetises an electro-magnet, which, by attracting its armature, draws the contact-maker (which is mounted on a piece of watch-spring) past the tooth into such a position that it catches behind a small plate of insulating material at the back of the tooth, which prevents it springing again into contact with the latter when the armature of the magnet is released.

Fig. 4 explains the calculation of the thermodynamic efficiency of this mode of transmission of power. It is drawn for unit volume of atmospheric air drawn into the air-pumps. The pressures are reckoned in atmospheres. A B C D E is the indicator-diagram showing the work done by the compressor-pump. The compression-curve C D is taken according to the law $p \propto v^{-1.2}$ because it seems probable that this index may be reached with the efficient water-cooling system adopted. The suction-line A B is taken $\frac{1}{25}$ atmosphere below atmospheric pressure. The point F is taken on the same isothermal as C; thus D F is the loss of volume consequent on the air cooling in the pipes down to atmospheric temperature. The diagram E F G H is the indicator-diagram for an engine driven by the air without loss of initial pressure below the compressor pressure, without clearance, without expansion, and with a back pressure $\frac{1}{10}$ atmosphere above atmospheric pressure. The same back pressure is used for all the other engine diagrams. The diagrams E F I K H, E F L M H, and E F N H are diagrams for engines with similar conditions, and with ratios of expansion $1\frac{1}{3}$, 2, and $2\frac{1}{2}$; that is, with cuts off $\frac{3}{4}$, $\frac{1}{2}$, and ^{2}, the last being that that brings the final pressure down to $1\frac{1}{10}$ atmosphere. The expansion-curve F I L N is taken as adiabatic. If $\frac{1}{5}$ atmosphere be lost in frictional and viscous resistance to flow through the pipes, by obstructions at bends, passage through meter, &c., or by sudden change of section of pipe, then the admission line is lowered to P Q. The effect of clearance is to cut off a part of the diagram by a vertical line at the left-hand end. This vertical line is not drawn in the diagram, because its position varies with the grade of expansion employed. In calculating the following results the clearance has in each case been taken as $\frac{1}{20}$ the volume of the cylinder. The area of the compressor-diagram is 1·6, and the efficiency is in each case obtained

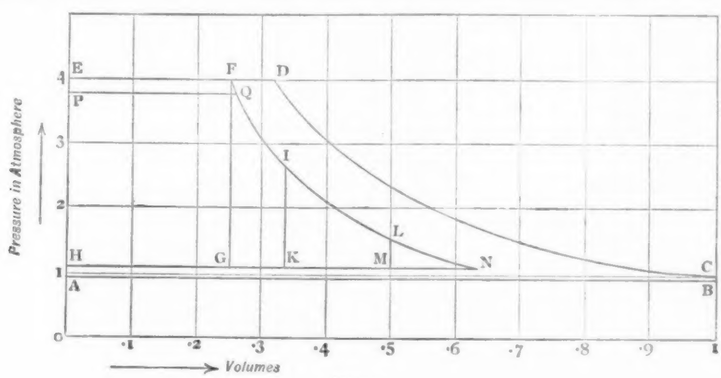


FIG. 4.

by dividing the engine-diagram area by 1·6, and multiplying this quotient by $\frac{9}{10}$. This $\frac{9}{10}$ is the ratio between the compressor-diagram and that of the central station engine which drives it, the mechanical inefficiency of this central plant being taken as $\frac{1}{10}$. The results are most clearly shown in tabular form.

Table of Efficiencies of Transmission of Power by Air compressed to 45 pounds per square inch

Ratio of expansion =	Efficiency 1		$1\frac{1}{3}$		2		$2\frac{1}{2}$
No loss of initial pressure No clearance Back pressure 1·1 atmos.	·45	...	·58	...	·67	...	·72
Initial pressure 3·8 atmos. No clearance Back pressure 1·1 atmos.	·42	...	·54	...	·64	...	·69
No loss of initial pressure Clearance $\frac{1}{20}$ vol. of cyl. Back pressure 1·1 atmos.	·39	...	·50	...	·57	...	·60
Initial pressure 3·8 atmos Clearance $\frac{1}{20}$ vol. of cyl. Back pressure 1·1 atmos.	·36	...	·47	...	·54	...	·57

The last two sections of this table comprise the limits of practicable results. The highest efficiency shown is 60 per cent. This could only be obtained by avoiding absolutely all loss of pressure between compressors and air-engine. This can hardly be accomplished even if the engine be situated close to the central works. It need hardly be pointed out that the expansion will not usually be carried so far as to bring the working pressure to near equality with the back pressure; in fact, to do so is decidedly very bad practice, and does not lead to economy in the brake-power, especially when depreciation and interest on first cost of the engine is taken into account. With good management, from 30 to 50 per cent. efficiency may be expected.

In a paper read by Mr. Sturgeon before the British Association last summer, he gives a table of calculated efficiencies ranging from ·32 to ·84. These calculations include allowances of 2 per cent. for valve-resistance and leakage past compressor-piston; 13 per cent. for leakage, friction, and wire-drawing in the pipes; and 8 per cent. for clearance and back pressure in the consumer's engine. Except the last, these allowances are much more liberal than those that have been made in calculating the above table. On the same basis as ours have been made, Mr. Sturgeon's calculations would have given considerably higher figures than the above ·32 to ·84. But the higher figures in Mr. Sturgeon's table are obtained by supposing that the consumer heats the air by a gas-stove, before passing it into his engine, up to temperatures from 212° F. to 320° F. How the resulting figures can be in any sense

called "efficiencies" it is difficult to understand. The consumer is supposed to supply a large extra amount of power at his own cost by burning gas to heat the air, and it seems an extremely evident misuse of the word "efficiency" to apply it to the ratio of the diagram so got to the diagram of the central station engine. By a little more liberal burning of gas, the efficiency obtained by this method could quite easily be made higher than unity. On the same principle we might calculate the efficiency of a steam-engine by taking the ratio of the indicator-card from the steam cylinder to that taken from the feed-pump that supplies water to the boiler, and thus obtain an efficiency of, let us say, 50,000 per cent. This is a *reductio ad absurdum* of the method of calculation which is perfectly legitimate and logical. R. H. S.

THE CLASSIFICATION OF THE CÆCILIANS

IN a paper on the structure and affinities of the Amphiumidæ, published in the newly-issued part of the Proceedings of the American Philosophical Society (vol. xxiii. No. 123), Prof. Cope has put forward some views as to the position of the Cæcilians or Apodous Batrachians in the Systema Naturæ, which are worthy of careful consideration. The Cæcilians, Prof. Cope observes, are generally regarded as representing a distinct order of the Batrachian class, which bears the name "Apoda," or "Gymnophiona." The definition of this order given by Mr. Boulenger in his recently published Catalogue of the specimens of these animals in the British Museum is: "No limbs; tail rudimentary; males with an intromittent copulatory organ; adapted for burrowing." Of these definitions Prof. Cope maintains that not one is of ordinal value. "The tail in some Cæcilians is distinct. The intromittent copulatory organ in such species as *Dermophis mexicanus*, *Gymnophis proximus*, and *Herpete ochrocephala* is not a special organ, but merely the everted cloaca. The hard papillæ observed by Günther in *Ichthyophis glutinosus* are wanting in the above-mentioned species, and the protrusion of the cloaca is performed by two special muscles."

As regards the absence of limbs in the Cæcilians, Prof. Cope points out that the extremely rudimentary character of these organs in *Amphiuma* is well known, and that their non-existence has no greater claim to be considered as of ordinal value in the Batrachians than in the adjoining class of Reptiles, where it is in some cases not even a "family" character. Looking to these facts, Prof. Cope proposes to unite the Cæcilians with the Urodele Batrachians, and to class them only as a family, "Cæciliidæ," connected with the more typical forms of the group through the Amphiumidæ.

Messrs. Sarasin, who have recently published a most interesting account of their observations on the development of a species of Cæcilian in Ceylon,[1] seem to have come to nearly the same conclusions as to the correct systematic position of this group of Batrachians.

[1] "Ueber die Entwicklungsgeschichte von *Epicrium glutinosum*," Arb. Zool. Inst. Würzburg, vii. p. 292 (1885).

NOTES

THE Prince of Wales has requested the President of the Royal Society to join the Committee appointed to advise on the organisation of the proposed Imperial Institute.

WE have referred elsewhere to some of the possible results of the meetings held last week in favour of the Imperial Institute. Some very striking features which have been developed in connection with this movement during the last week are, first of all, the considerable desire which has been evinced, to enrich various localities with some Jubilee memorial, and, again, the wisdom generally displayed in selecting worthy local objects, such as museums, improved science schools, and the like. All this of course is admirable and entirely to be applauded, but believing as we do that there is a possibility of the Imperial Institute, if properly conducted, doing more good for the future development of science and commerce in Greater Britain than any other single organisation can possibly effect, we hope that it will not be starved in favour of merely local objects. We hear that the women of England have already subscribed a noble sum. This no doubt Her Majesty will hand over to the Institute, if it is organised so as to command the confidence and respect of the various leaders of opinion in this country and in the colonies.

MANY of our readers will attach much importance to Colonel Donnelly's letter, which appears in another column. A large increase in the number of students anxious to enter the Normal School of Science and Royal School of Mines was of course to be expected, and we are glad that this influx has induced the department to take steps to increase the accommodation, and at the same time to insist upon one of the best possible forms of entrance examination; a strict inquiry, namely, into the educational history of each candidate for admission.

THE Norwegian Government has presented a Bill to the Storthing for fixing a standard time for the whole of Norway. The standard time proposed is Greenwich time *plus* one hour.

MR. W. BALDWIN SPENCER, Fellow of Lincoln College, Oxford, has been appointed to the Chair of Biology in the University of Melbourne, and will leave England in about three weeks. Mr. Spencer distinguished himself lately by his important memoir on the pineal eye in lizards.

A NUMBER of eminent men of science have addressed a memorial to the President, Vice-Presidents, and Council of the Royal College of Surgeons of England, suggesting that the legacy bequeathed to the College by the late Sir Erasmus Wilson might with advantage be devoted to the establishment of an institution having for its object "physiological and pathological research." It is pointed out that the want of such an institution in England has long been felt, and more especially of late, when we have had to look to Berlin for information respecting tubercle, and to Paris for experiments on the prevention of hydrophobia. That the Government will do anything in the matter no one is so sanguine as to believe; and it is hardly more probable that the want will ever be supplied by public subscription. There is, therefore, much to be said for the present proposal, and the authorities of the College of Surgeons will, no doubt, give it due attention. It seems strange that in London there should be nothing like the splendid laboratories which exist not only in the capital cities of Europe, but in comparatively small German towns, such as Bonn, Strasburg, and Leipzig.

UNIVERSITY COLLEGE, Liverpool, has reason to congratulate itself on having some remarkably generous and enlightened friends. On Tuesday last it was announced at a meeting of the College Council that Mr. Thomas Harrison, shipowner, of Liverpool, had endowed the Chair of Engineering with 10,000*l*. Only a few weeks ago Sir Andrew Walker, also a citizen of Liverpool, gave 15,000*l*. to build Engineering Laboratories.

ON Thursday last the honorary freedom of the City of London was conferred upon Mr. H. M. Stanley, in recognition of his services as a traveller and explorer in Africa. The presentation was made at a special meeting of the Court of Common Council in the new council chamber at the Guildhall. The City Chamberlain, in making the presentation, referred to "the remarkable development of journalistic enterprise during the Victorian era," observing that Mr. Stanley was the first member of "the

class of special travelling and war correspondents" whom the City had enrolled among its freemen. Mr. Stanley was evidently much pleased by the honour done to him, and declared that it would stimulate him to further exertions. After luncheon at the Mansion House, he spoke of the various routes which have been proposed for the expedition for the relief of Emin Pasha.

MR. ALFRED RUSSEL WALLACE lately delivered, at Boston, U.S.A., a course of "Lowell Lectures." He proposes to make a Western tour, in the course of which he will lecture on, among other subjects, "The Darwinian Theory: What it is, and How it is Demonstrated," "The Origin and Use of the Colours of Plants," "The Permanence of Oceans, and the Relations of Islands and Continents," and "The Biological History of Continental Islands, Recent and Ancient." Mr. Wallace is thought by the Americans to be a more effective speaker than most of the eminent Englishmen who have lectured in the United States.

THE Indian Survey Staff seems to be considerably undermanned. The Government of the Straits Settlements recently applied to the Government of India for an experienced officer to advise them on the way of placing the system of survey in the colony on a satisfactory footing. As no qualified officer on the former establishment was available, Mr. J. B. N. Hennessey, now on the retired list, was offered the duty, but as he declined it the Straits Settlements Government had to be told that the Government of India could render no assistance on a work so necessary to the development of the colonial resources, and likely to be of so much service to science.

A MOVEMENT is on foot at Gothenburg for the founding of a free University in that city. A large sum of money has already been subscribed.

THE results of the new censuses of France and Germany show a marked falling-off in the rate of increase. In the case of France the rate of increase was low enough before; now it threatens to stop altogether, and in many departments there has been a considerable decrease. The addition to the population in five years has only been 213,857, bringing the total up to 37,885,905. This is equal to an annual rate of only ·1 per cent. per annum. Germany is not quite so bad, but the rate of increase between 1870 and 1880 was abnormally high. The population by the latest returns is 46,844,926 as compared with 45,234,061 five years before; giving an annual rate of increase of ·71 per cent. per annum in 1880-85, as compared with 1·14 per cent. per annum in the previous five years.

THE Lieutenant-Governor of the Punjab has proposed to the Government of India the establishment of a University at Allahabad, and has furnished a scheme for such an institution in the capital of his province.

AT the afternoon sitting of the Association for the Improvement of Geometrical Teaching, held at University College, on the 14th inst., the President (R. B. Hayward, F.R.S.) in the chair, the Rev. G. Richardson, of Winchester College, read a paper on the teaching of modern geometry, in which he indicated the lines which, in his opinion, a Syllabus on the subject should follow. The draft, which covered an extent of ground too great, we think, for ordinary school-teaching, did not consist of a bare enumeration of the subjects of sections and chapters, but was rendered very interesting by the quaint humour which lightened up and pervaded the whole. The Rev. J. J. Milne read a short note on a part of the above subject, which had been omitted by the previous speaker, viz. the modern treatment of maxima and minima; his strong point was the light to be derived from symmetry in the search for cases of maximum and minimum. Mr. G. A. Storey, A.R.A., read a paper on "Geometry from the Artist's Point of View." In this the writer introduced Euclid and Apelles in converse, and showed the agreement which exists between the purely geometrical method and perspective. The paper was illustrated by numerous drawings of triangles, squares, and cubes. A brief discussion of the several papers followed, and then Mr. E. M. Langley communicated a very simple proof of Feuerbach's theorem (that the nine-point circle touches the in- and ex-circles of the triangle). We may return to the consideration of one or more of the above papers when they have been printed in the Association's Report. Upwards of twenty new members were elected.

WE have received a hand-book entitled "Through the British Empire in Ten Minutes with C. E. Howard Vincent, Esq., C.B., M.P." It is intended to accompany a wall-map on which Mr. Vincent has brought together a large amount of useful information about the British Possessions. In his hand-book he glances at the leading characteristics of each of the great groups into which the Empire beyond the seas is divided.

A STATE weather-service for Pennyslvania is to be formed at Philadelphia by the Franklin Institute. The State Legislature will be petitioned for an appropriation of 3000 dollars for instruments and publications, and it seems to be assumed that so reasonable a request will be readily granted.

THE Americans also have a Society for Psychical Research. The Society proposes to issue the next number of its Proceedings as soon as sufficient material can be collected. Apparently it is not quite so easy to get startling evidence of the "psychical" kind in the New World as in the Old.

DESCRIBING in an American medical journal the influence of the recent earthquake shocks in Charleston upon the health of the inhabitants, Dr. F. Peyre Porcher, of that city, says that many persons experienced decidedly electrical disturbances, which were repeated upon the successive recurrence of the shocks. These disturbances were generally accompanied by tingling, pricking sensations, like "needles and pins," affecting the lower extremities. One gentleman was completely relieved of his rheumatism; another, who for months was nervous, depressed, and entirely unable to attend to business, regained his former activity and energy.

AN interesting sketch of the great Serpent Mound in Ohio is given in *Science* by Mr. W. H. Holmes. It is in the northern part of Adams County, somewhat remote from frequented routes of travel. The entire body of the serpent and the peculiar features of the enlarged portion are all distinctly traceable, and leave no doubt in the mind, Mr. Holmes thinks, as to their artificial character. He is decidedly of opinion that the work should be classed among the products of the religion of the aboriginal races.

MR. J. H. STEWART LOCKHART, of Hong Kong, has addressed, on behalf of the Folk-Lore Society of England, an appeal in the English and Chinese languages, through the press, to students throughout China to co-operate in investigating the folk-lore of that country. He points out that no attempt has been made to deal with this subject as a whole, the work done so far being for the most part of a local character. He now proposes to obtain collections of the lore peculiar to different parts of the empire and its dependencies. Each collection, he goes on, while in itself highly instructive, will be chiefly important as forming a link in the chain of facts from which a general account of the folk-lore of China may be deduced. The Chinese version of the appeal is intended for circulation amongst natives, who, "experience shows, evince a great interest in the subject when once they comprehend its aims and objects." Competent scholars are scattered over the greater part of China, and, as

Mr. Lockhart says: "If willing helpers can be found to assist in the work of collection, the success of the scheme is assured. Failure can only result from want of co-operation and support."

IN a paper entitled "Thirty-six Hours' Hunting among the Lepidoptera and Hymenoptera of Middlesex," reprinted from the *Journal of Microscopy and Natural Science*, Mr. Sydney T. Klein has some interesting notes on the best methods of capturing Lepidoptera. He has found it very useful to take advantage of "the attractiveness of the ladies among the Lepidoptera gentry." To those who have not had experience, or have not persevered in, this art, he says, the result is truly marvellous, and will sound very much like a fairy tale. The good taste possessed by the males of Lepidoptera is shown to the greatest perfection among the Bombycidæ. On several occasions, when on botanical excursions in Hertfordshire, Mr. Klein has taken with him a female of *Bombyx quercus*, or other Bombycidæ, fresh from the pupa; and, in a wooded country, provided the sun was hot and a gentle breeze blowing, he was certain of having, within ten minutes, a dozen of the opposite sex flying round him, and from time to time even settling on his shoulders or hands. On one occasion, after remaining, as an experiment, for some time on the same spot, he counted over forty of these large moths within fifty yards.

NEGOTIATIONS are being carried on in Denmark for the holding of a Fisheries Exhibition in Copenhagen next year.

AN enthusiastic fish-culturist is trying to introduce scaleless fishes into English fresh waters. In a lecture on Fish, lately delivered at Worcester, and now published, Dr. Francis Day, C.I.E., expresses his belief that they will prove worthless for sport, almost, if not entirely, useless as food, and dangerous to handle on account of the spines with which they are protected. These fishes delight to eat other forms of fish-life. "I obtained," says Dr. Day, "a specimen of a common Indian catfish at Madras, which I placed in an aquarium that contained some carp. It rushed at one of my poor little fishes, and, before I could interfere, seized it by the middle of its back and shook it until it was dead, as a dog kills a rat."

AT the monthly meeting of the Council of the Sanitary Assurance Association on January 10, the Sanitary Registration of Buildings Bill was re-considered. A report on the draft Bill was submitted, with several clauses re-drawn. The Bill was further amended, and ordered to be printed for final consideration at the next meeting of the Council. It is proposed that the new Bill shall be compulsory with regard to schools, hotels, asylums, hospitals, and lodging-houses, and Clause 6 has been made much more stringent in the matter of qualification of persons entitled to give sanitary certificates.

BARON VON MUELLER, who retains the office of Government Botanist to the colony of Victoria, is about to issue a series of plates with descriptions of the acacias (wattles) of Australia. The work will be similar to the "Eucalyptographia," probably the best and most useful of his publications. For diagnostic purposes he makes use of two characters hitherto overlooked, viz. the number of divisions in the pollen-mass and the position of the seed. The retirement of Baron von Mueller from the direction of the Botanic Garden, some few years since, has enabled him to devote more attention to scientific botany and its applications to practical purposes.

DR. GILES, who was attached as scientific member to the Chitral-Kafirstan Mission, is now stated to be in Calcutta, engaged in writing a report on the geology of that region.

CAPT. PEACOCKE, R.E., is said to be preparing a report, with sketches, of his experiences with the Afghan Boundary Commission.

ON Thursday evening last the Society of Telegraph-Engineers and Electricians held the first general meeting of the session of 1887. Sir Charles T. Bright, the new President, delivered an address on the history of the electric telegraph. Speaking of the progress which has been made since the property of the Telegraph Companies was bought by the State, he said that in 1870, when the transfer was completed, there were 48,378 miles of land wires, and 1622 miles of cable wires (irrespective of railway wires), connecting together 2488 telegraph stations. Now the Post Office has 153,153 miles of wire (including submarine wires) in communication with 5097 offices. In addition, the railway companies have 70,000 miles of wire, making a total of 223,153 miles.

THE additions to the Zoological Society's Gardens during the past week include a Red-fronted Lemur (*Lemur rufifrons* ♂) from Madagascar, a Vervet Monkey (*Cercopithecus lalandii* ♂) from West Africa, presented by Mrs. Pawelzig; a Patas Monkey (*Cercopithecus patas* ♀) from West Africa, presented by Mr. George Ellis; a Common Otter (*Lutra vulgaris*), British, purchased.

OUR ASTRONOMICAL COLUMN

NEW VARIABLES IN CYGNUS.—A new variable of the Algol type (D.M. + 34°, No. 4181, R.A., 1887·0, 20h. 47m. 32·5s., Decl. 34° 13′ 59″·5 N.), has been discovered by Dr. Gould. Its period is about three days in length, and it varies from 7·1 mag. to 7·9 mag. A minimum occurred at about 10h. 19m. G.M.T. on January 17. This discovery raises the number of stars of the type to eight, the other seven being Algol, period 2·49d.; λ Tauri, 3·95d.; S Cancri, 9·48d.; δ Libræ, 2·32d.; U Coronæ, 3·45d.; U Cephei (D.M. 81°, No. 25), 2·49d.; and U Ophiuchi (DM + 1°, No. 3408), 0·839d.

Mr. S. C. Chandler, Jun., in a note in Gould's *Astronomical Journal*, No. 148, calls attention to a new short-period variable very close to the above. This star (Lalande 40083, R.A., 1875·0, 20h. 38m. 30·2s.; Decl. 35° 8′ 24″·6 N.) varies from 6·3 m. to 7·6 m. in a little over fourteen days, the increase occupying about four days, the decrease ten days, with a halt in the latter about midway of its course. Mr. Chandler gives for first elements of the star, 1886 October 3·60 G.M.T. + $14^{d}\cdot04$ E.

NEW MINOR PLANET.—Prof. C. H. F. Peters, at Clinton, discovered a new minor planet on December 22. This will be No. 264, and the forty-sixth discovered by Prof. Peters.

A NEW METHOD FOR THE DETERMINATION OF THE CONSTANT OF ABERRATION.—In the *Comptes rendus*, tome civ. No. 1, M. Loewy explains how the principle of his method of determining the amount of astronomical refraction (NATURE, vol. xxxiii. p. 303) can be applied to the determination of aberration also. By means of the two reflecting surfaces forming the double mirror placed in front of the object-glass of an equatorial, the images of two stars situated in different parts of the sky appear, in the field of view, side by side; their angular distance is then to be measured in a known direction. To obtain the amount of aberration it is, of course, necessary to measure a properly chosen pair of stars at successive epochs. The first observation is to be made when the stars are at the same height above the horizon, and the second, after a certain interval, under similar conditions. The comparison of the two measures will give a multiple value of the aberration which is independent of instrumental errors. By a proper choice of the angle of the double mirror employed, of pairs of stars selected for measurement, and of the circumstances of observation, M. Lœwy contends that, by attention to the details which he specifies, a more accurate value of the constant of aberration can be obtained by his method in an interval of three months than could be deduced by the methods hitherto in vogue, liable as these are to systematic error.

THE MADRAS OBSERVATORY.—In his Report for the year 1885, Mr. Pogson states that the volume of telegraphic longitude determinations in India, and the two volumes of hourly magnetical observations made at Singapore between 1841 and 1845, and at Madras between 1851 and 1855, which were men-

tioned as ready for issue in the last Report, were distributed in 1885. Mr. Pogson's attention was chiefly directed, during the year, to the necessary preliminary investigations for the publication of the meridian-circle observations from 1862 to the present time. The formation of the star ledgers and the deduced catalogues of mean positions for each year were completed for the years 1862, 1863, and partly for 1864, which will form the first of the eight volumes about to be published. The star ledgers for the next three years—1865-67—are also in progress, for the second volume of the series. Except for time observations and determinations of positions of a few comparison stars for equatorial observations, the meridian-circle will be little used until the publication of its past results is accomplished. Only 352 complete positions of stars were determined in 1885, making 52,074 during the past twenty-four years. A few o servations of minor planets were made with the equatorials during the year. We are glad to find that there is at length a prospect of the publication of the Madras meridian observations, the long delay in which has been a serious blot on the fair fame of the Observatory.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 *JANUARY* 23-29

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on January 23

Sun rises, 7h. 54m.; souths, 12h. 12m. 4·4s.; sets, 16h. 30m.; decl. on meridian, 19° 27′ S.: Sidereal Time at Sunset, 0h. 41m.

Moon (New, January 24) rises, 7h. 14m.; souths, 11h. 40m.; sets, 16h. 9m.; decl. on meridian, 18° 13′ S.

Planet	Rises	Souths	Sets	Decl. on meridian
	h. m.	h. m.	h. m.	° ′
Mercury	7 38	11 34	15 30	23 0 S.
Venus	8 34	13 4	17 34	17 34 S.
Mars	8 49	13 36	18 23	14 36 S.
Jupiter	1 0	6 2	11 4	11 54 S.
Saturn	14 59	23 6	7 13*	22 6 N.

* Indicates that the setting is that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

Jan.	Star	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image
			h. m.	h. m.	° °
28	4 Ceti	6	19 16	20 13	179 296
28	5 Ceti	6	19 42	20 26	196 281

Variable Stars

Star	R.A.	Decl.		h. m.	
	h. m.	° ′			
U Cephei	0 52·3	81 16 N.	Jan. 26,	22 21	*m*
λ Tauri	3 54·4	12 10 N.	,, 24,	20 33	*m*
			,, 28,	19 25	*m*
ζ Geminorum	6 57·4	20 44 N.	,, 29,	0 0	*m*
S Cancri	8 37·5	19 26 N.	,, 24,	0 55	*m*
R Virginis	12 32·8	7 37 N.	,, 26,		*M*
V Virginis	13 22·0	2 35 S.	,, 23,		*M*
δ Libræ	14 54·9	8 4 S.	,, 24,	18 23	*m*
			,, 27,	2 15	*m*
U Coronæ	15 13·6	32 4 N.	,, 27,	19 21	*m*
U Ophiuchi	17 10·8	1 20 N.	,, 25,	3 30	*m*
		and at intervals of		20 8	
R Scuti	18 41·4	5 50 S.	Jan. 27,		*m*
β Lyræ	18 45·9	33 14 N.	,, 26,	3 0	*M*
δ Cephei	22 25·0	57 50 N.	,, 28,	1 0	*m*

M signifies maximum; *m* minimum.

Meteor-Showers

On January 28 a radiant near δ Coronæ Borealis is in evidence. The meteors from this radiant are very swift, R.A. 236°, Decl. 25° N. Another radiant giving very swift meteors lies near σ Leonis, R.A. 168°, Decl. 7° N.

GEOGRAPHICAL NOTES

IT is all but certain that Mr. Stanley will lead the Emin Pasha Relief Exploration by the Congo route. He will certainly go to Zanzibar, prepared to follow whatever route circumstances may indicate as likely to prove the most successful. At Port Said he will meet with Dr. Junker, who may give him information of critical importance. At all events, Mr. Stanley and his staff and the whole of the baggage will proceed, in the first instance, to Zanzibar. If a steamer is handy, the Expedition, after recruiting a caravan and laying in a store of suitable goods for trade by the way, will sail round the Cape to the Congo; that at least is Mr. Stanley's present intention. All the available steamers belonging to the King of the Belgians will be placed at his disposal, and probably by the beginning of May he will be at the limit of navigation and ready for his land journey eastwards to Lake Albert Nyanza; if, indeed, he does not give the lake a wide berth westwards and go direct to Wadelai. A camp as a base of operations will be established, as far as safe from the Congo, and left in charge of a trustworthy member of the staff. About fifty donkeys will be taken to carry the heavy baggage, and the caravan will consist of about 100 men, with a few Egyptian soldiers to maintain discipline. The staff consists of half-a-dozen carefully selected men, among whom are two able engineer officers, under whose care the interests of science will be attended to. Four or five carefully rated chronometers and other instruments are being taken, so that we may expect some good results. It is probable that Mr. Stanley will endeavour to solve the Albert Nyanza and the Wellé-Mobangi problem, as well as other obscure points in African hydrography, on his return journey. It is to be hoped that Emin Pasha will not think of coming away, as Dr. Junker states he wishes to do; but if he does, then no doubt Mr. Stanley will be able to make arrangements to carry on the work which Emin has begun so well. Mr. Stanley leaves England to-morrow, and the good wishes of all will go with him. He is confident of being able to reach Emin Pasha by July 1, and possibly may be back in Europe about Christmas; in that case, we fear, he could not do much exploring work.

DR. LENZ has at last arrived at Zanzibar, having taken less than eighteen months to cross the African continent from the mouth of the Congo. A fortnight ago we gave some account of his journey up the Congo from Stanley Falls to Nyangwe and Kasonge; it will be interesting to know what route he followed after leaving the Upper Congo. It will be remembered that Dr. Lenz went out eighteen months ago for the purpose, if possible, of reaching Emin Pasha and Dr. Junker. From Zanzibar the late Dr. Fischer started through Masai Land on a similar errand. In both cases the object has not been accomplished, and no wonder, now that we know the real facts. Much good work, however, has been done by both men. Dr. Lenz is a man of scientific training and experience in African travelling, and there can be no doubt that the results of his just completed journey will be a gain to science. It is possible that Mr. Stanley may meet with Dr. Lenz on his way to Zanzibar; and if so may obtain some information that will be of service on his great expedition.

THE Rev. Thomas Brydges, a missionary in Tierra del Fuego, in the large island of Onisin, among the Ona and the Yagbons, mentions a curious circumstance with reference to the people, illustrating the influence of environment on the acquirement of habits. Between men and women there is a fair subdivision of labour. Among other things, the men make and fit up the canoes, but the women are the rowers. The result is that the women are good swimmers, but the men cannot swim at all. The reason is that often on the coast there is not a single tree to which to fasten the canoes. The women, therefore, after landing their husbands, have to row the canoes to a spot where sea-weed has been massed together, in order to moor the canoes thereon; after which operation they are compelled to swim back. So, also, when the canoe is wanted, the woman has to swim out for it and row back for her husband.

THE current number of the *Mittheilungen* of the Geographical Society of Vienna (Band xxix. No. 10) has a large map of the route from Ango-Ango to Leopoldville, made by Herr Baumann, of the Austrian Congo Expedition, with accompanying remarks, and a comparison with other recent maps of the same part of the river. There is an interesting note by Herr Baumann on the numerical systems of the Why or Wai Negroes and of the Mandingoes. The former, although they have a writing of their own—the Mandingoes use Arab letters—have no expression in their language for 100, and use the English, while the Mandingoes, Bantus, and other tribes can count with ease up to 1000. Herr Baumann also writes on the region around Stanley Falls,

and its inhabitants. The two remaining papers are mainly geological, one being on the geography of Persia, by Dr. Tietze, the other the conclusion of Dr. Diener's paper on the hypsometry of Central Syria.

EXPERIMENTAL SCIENCE IN SCHOOLS AND UNIVERSITIES

PROF. G. F. FITZGERALD, as Vice-President of the Dublin University Experimental Science Association, delivered an address at the opening meeting, held on November 23 in the Museum Buildings of Trinity College, under the presidency of the Rev. the Provost, on "Experimental Science in Schools and Universities."

Prof. Fitzgerald, at the outset of his address, dealt with the history of Universities, and showed how they gave such preponderance to book as against experimental knowledge. That had led, the Professor continued, to a dual system of education—the professional and the commercial. That gap between the classes was much to be lamented, and necessitated, from a political point of view, the desirability of having all classes educated in the same institutions. The commercial classes would not, however, enter the Universities at present, because they required to be taught useful subjects, and they would not learn the Latin and Greek now required in our Universities. From the political side of the question, he thought, they had got these results—that they must be content to have useful subjects taught in their schools and Universities if the schools and Universities were to be used by the large body in the country who were willing and able to pay for it. What they must have, if possible, was a single school and college system for all classes of the community who were able to spend the first twenty years or so of their life in education, and they ought to have a system that was complete, a training which gave both those who could not afford to go on the whole length up to twenty years, and which ought to be able to train those who desired to go on for the higher culture. Returning to the education side of the question, he insisted that almost the whole importance was as to how the subject was taught. He thought the use of the Latin Grammar had been reduced to a very good system, but he thought it was perfectly evident from the course that things were taking and the reasonableness of things, that they must teach their youth some knowledge of science. People who felt responsibility in the matter were being more and more convinced that it was not right for them to allow their children to grow up ignorant of the laws of the world in which they live. Others made answer to that that they left those laws of the world to the doctors. But how were they to know under what circumstances it was well to consult a specialist? It was very necessary for us to have a knowledge when we required to consult a doctor. Hundreds of people were killed by ignorance of the fact that dirt was the cause of disease. That was a very elementary subject. Nevertheless, people were dying every day from ignorance of that very fact; and, unless they were taught to believe in the fact that there were laws of Nature, they would not believe that dirt was the cause of disease, because they saw some people living in dirt and yet not the victims of disease. He thought that time for teaching science must be found for these two reasons—it was necessary that our youth should learn the laws of the world in which they live, and that they also should learn how to discover those laws. Unless our people were taught the laws under which plants and animals were best grown, the people of other countries would rival them in the manufacture of butter and beef, and the result would be that our people must starve. Another advantage of such training was to prevent superstition such as that of the people of Spain, who preferred the use of charms as a safeguard against cholera to the cleansing of their wells. All the classes of the country required this training—they would die without it, so they must have it.

Having shown that the cultivation of Latin and Greek was originally with the view of acquiring the information contained in the ancient books in those languages, the Professor combated the five reasons formulated by the German professoriate as to why they thought that the cultivation of Latin and Greek was so important, observing, with regard to the fourth reason—that these languages were the best varied exercise in thinking—that if the connection between words and ideas was a thing that must be taught in every system of education, his impression was that that would be a great deal better attained by describing accurately and thinking out the consequences of physical experiment. In choosing the sciences that they should teach, there were three conditions that should be fulfilled. First of all, the sciences chosen ought to be within the grasp of children, because it was highly important that the science begun with childhood should be continued on in the University days; secondly, it ought not to require any expensive apparatus, because schools and people who trained children could not be expected to buy elaborate apparatus, and children could not be expected to work with them satisfactorily; and, thirdly, he thought the sciences should be chosen so as to be concerned with a large number of the laws of the world in which we live. There were two large branches of science which included nearly all the laws of the world, namely, the physical and the biological; and, therefore, he thought it would be desirable to choose two sciences—one on the physical and one on the biological side, so that children might learn something about the laws of living things, and something about the laws of physical things. He therefore suggested chemistry and botany, and he thought the whole weight of their efforts should be devoted to trying to get the children in schools to learn the elements of chemistry and the elements of botany, for there were no other two sciences the elements of which were almost similar, and at the same time there were no other two sciences that led up to a greater number of the laws of life, nor that gave a wider and more extended view of the laws of the world in which we live. The objections to the present system of teaching a knowledge of experimental science was that it almost entirely concentrated the person's attention upon phenomena instead of upon reasoning. Therefore, in choosing their system of teaching, all their weight ought to be thrown into making sure that their plan had the effect of making the child learn to think a good deal. Another thing they had to consider was the enormous time that children were made to remain in school without being engaged in anything except mischief. He thought a child should not spend more than four hours a day at literary work. Well, that occupied but a small part of a child's day; and one of the great advantages of having experimental subjects introduced into school teaching would be that they were subjects at which a child could work without experiencing very much fatigue. He could not help calling attention to the flagrant abuse of the teaching of experimental science in Irish schools. Experimental science in Irish schools was very nearly the same as snakes in Iceland. Having pointed out the fallacy of an examination—as exemplified in the Intermediate Education system—that was satisfied with a reading of the musical signs unwedded to a knowledge of the sounds they represented, the Professor said it would be an enormous advantage if the Intermediate Commissioners could be induced to keep up a peripatetic system of periodical examinations that would insist upon practical knowledge. That, however, should not interfere with the giving of papers also. After observing that it was at the present time impossible to carry out a proper examination in laboratory work, and stating that he considered it would be very desirable that the actual work in the laboratory and analyses in practical subjects should count towards the University prizes, Mr. Fitzgerald said he considered that the present system of analysis was not very satisfactory, and he urged the introduction of a system that would teach chemistry practically. Though that might be harder to teach than Latin and Greek, it would not be so if they had a system worked out and teachers to promote it, and it would have the inestimable advantage that, in addition to training the child to think—which he thought it would do equally well with Latin and Greek—it would teach him the laws of things, and how to see and learn the laws of things. It would also teach the child to use language to express real ideas, and not merely phrases. They would also learn a good deal more of the laws of language from a modern language that they learned with the grain than they would by learning an ancient language against the grain. He thought that literature and history were co-ordinate with science, and they certainly ought to be a large part of education. Literature and history were grievously neglected in the present day—practically they had no place, and that was substantially because Latin and Greek were supposed to be a literary education. One of the reasons was that those subjects were hard to examine in, but there was an easy way out of that difficulty in Universities. They need not examine, but they could require attendance at lectures—attendance on good lecturers; and the student would pick up more

culture and would be obtaining a better literary education from hearing a good lecturer and being inspired by his enthusiasm than he would get by learning off one of Shakespeare's plays, and answering it at an examination. Those two aspects of education, the literary and scientific, were often put in opposition, just as the freedom of the individual and the power of the State to control the individual were very often set up in opposition to one another; but he did not think any one would believe that that opposition really arose, for the freest States were those in which the power of the State was the strongest. In conclusion, he would say that we must equip our youth for the battle of life physically and ethically. The present is a great crisis in Irish education. There is danger of science schools starting, and all the evils of dual education. There are a large body who like Latin and Greek, because they exclude literature and history. These are to be fought tooth and nail. There are those who would sacrifice the rising generation on an altar of so-called culture to starve and die, with their only comfort that they can describe their agony in well-expressed phrases. There are those who would grind all soul out of mankind in a mill of manual labour, constructed on scientific principles. All those are to be guarded against. We must have literature and history. We must have knowledge of the laws of the world in which we have to work. We can have both if we will but work out a reasonable system of education, instead of pretending that the lop-sided corpse that occupies our schools and Universities is a well-developed, symmetrical giant.

ABORIGINAL ART IN CALIFORNIA AND QUEEN CHARLOTTE'S ISLAND

IN the fourth volume, recently issued, of the Proceedings of the Davenport Academy of Natural Sciences there is a valuable article by Dr. W. J. Hoffman on "Aboriginal Art in California and Queen Charlotte's Island." In the summer of 1884 Dr. Hoffman visited the Pacific coast for the purpose of continuing his researches on primitive art, and he was fortunate enough to find a number of localities in which there are painted and "etched" records, of considerable interest, made by Indians belonging to tribes now unknown. These records occur in groups. One group, the first described by Dr. Hoffman, is in the neighbourhood of Santa Barbara. The best preserved paintings in this series are in a cavity which measures about twenty feet wide and eight feet high. The rock consists of gray sandstone, but the ceiling and back portion of the cave have a yellowish appearance. The colours employed were red ochre, white, and bluish black. Some of the paintings Dr. Hoffman takes to be representations of gaudily-coloured blankets. In several instances a grotesque human figure is drawn over or in front of what seems to be a blanket, as if the latter were intended as a body blanket or serape. In the Azuza cañon, about thirty miles north-east of Los Angeles, Dr. Hoffman examined a second series of painted records. Rudely sketched human figures are represented as pointing in certain directions, and the intention evidently was that they should serve as guides to travelling parties. For instance, the left arm of a figure on a white granitic boulder points towards the north-east. The precipitous walls of the cañon make egress in that direction impossible, but two hundred yards further on the cañon makes a sharp turn towards the north-east, and in rounding the point of land to the right the traveller comes to another boulder, on which are numerous faint drawings of various kinds. This boulder is on the line of an old trail leading from the country of the Chemehuevi, on the north of the mountains, down to the valley settlements of San Gabriel and Los Angeles. A third series of records was found in the southern part of Owens Valley, California, between the White Mountains on the east and the Benton Range on the west. They are "etched," not painted. The most common characters in this group are circles, either plain, nucleated, bisected, concentric, or spectacle-shaped, by pairs or threes, with various forms of interior ornamentation. This group resembles etchings in the Canary Islands so closely that the illustrations given by Dr. Hoffman serve for both localities. On one of his plates he presents a number of circles with ornamented interiors, from a simple bisection to the stellate and cruciform varieties. Similar circles bearing cross-lines occur at Grevinge, Zeeland; and other forms resembling some at Owens Valley are found at Slieve-na-Calliagh, Grange, and Dowth, in Ireland. The spectacle-shaped variety resembles the mysterious symbol on some Scottish monuments which has given rise to so much vague speculation. The reversed Z, however, is wanting in the Californian examples. Of the various outlines of the human form presented by Mr. Wallace from Brazil, and referred to more recently by Prof. Richard Andree in "Ethnographische Parallelen und Vergleiche," a considerable number are almost identical with etchings in the Owens Valley series. Many of the characters in these three Californian groups are similar to, and some are indistinguishable from, those made by the Moki and other tribes of the Shoshonian linguistic stock. Further research on the same lines may, therefore, enable anthropologists to determine the former geographical area of the Shoshonian family, as has already been done in the case of the Algonkian tribes.

In the neighbourhood of Los Angeles Dr. Hoffman obtained a portion of an old Indian gravestone. On this slab there are incised characters which seem to represent a whale-hunt, and no doubt they were intended to denote the occupation of the person to whose memory the tablet was erected. Honour is done to the dead in a similar manner by the Innuit of Alaska and by the Ojibwa. Among the Innuit, the posts erected for men usually bear rude drawings of weapons and animals; those for women have representations of household utensils and implements. On Ojibwa gravestones, as Mr. Schoolcraft has noted, the totem of the deceased is drawn in an inverted position.

Dr. Hoffman offers some interesting remarks on the subject of tattooing. In former times, in the vicinity of Los Angeles, every chief caused the tattooed marks upon his face to be reproduced upon trees or poles which indicated the boundaries of his land; and as these marks were well known to neighbouring chiefs, they were a sufficient warning that trespassers would be punished. A custom akin to this prevails in Australia, where the tattooed designs upon the face of a native are often engraved upon the bark of trees near his grave. Among many of the tribes west of the Mississippi there are still numbers of persons who bear tattoo marks upon the chin, the cheeks, and even upon other parts of the body, but the marks seldom occur in any forms other than narrow lines, except among the Haida Indians of Queen Charlotte's Island, where the art of tattooing has reached a higher degree of development than on the mainland. The Haidas tattoo upon the back, breast, fore-arms, thighs, and the legs below the knees; and women submit to the operation as well as men. The characters are totemic, and represent either animate or mythologic beings. They are usually drawn in outline, with interior decorative lines, red being sometimes introduced to form what is supposed to be a pleasant contrast. The ceremonies at which the tattooing is done are held in the autumn, and extend over a period of several weeks. Among the figures generally adopted are the thunder-bird raven, bear, skulpin, and squid. A former Factor of the Hudson's Bay Company told Dr. Hoffman that when he first went to the country occupied by the Haida Indians he saw no tattooing upon the bodies of the older members of the tribe; and he contends that they have learned the art from natives of some of the South Pacific Islands, which they occasionally visit as traders.

The Haidas display considerable skill as carvers in wood and slate. Totem posts are often placed before the council-houses, and more frequently before private dwellings. When the posts are the property of some individual, the personal totemic sign is carved at the top. Other animate and grotesque figures follow in rapid succession down to the base, so that unless one is familiar with the mythology and folk-lore of the tribe the subject would be utterly unintelligible. On one post to which Dr. Hoffman refers there are only seven pronounced carvings, but they relate to three distinct myths. On household vessels, the handles of wooden spoons, and other objects, the Haidas often carve the head of a human being in the act of eating a toad. Sometimes the toad is placed at a short distance below the mouth. The idea is that in the wooded country there is an evil spirit who has great power of committing evil by means of poison extracted from the toad. The Indians are not willing to acknowledge the common belief in this mystic being, even when they are aware that the inquirer is in possession of the main facts.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The long-expected reform of the examination system which makes it unnecessary for men reading mathematics and natural science to pass any examinations of a non-scientific

character after coming into residence has at last been accomplished. The arrangement, which comes into force with the beginning of this year, is that candidates for degrees in mathematics and natural science take up responsions (or some equivalent examination at school) like other people, but by passing in one extra subject they are excused the second classical examination, in preparing for which they used to waste a good part of their first year of residence. The extra subjects from which candidates may choose include Greek, Latin, French, and German authors, Bacon's "Novum Organum," and the elements of logic. This alteration will be an undoubted benefit to science men, for, as the new examination involves no preliminary residence and occurs four times a year, they can proceed at once to take up the subject which they have chosen for their final schools.

The following courses of lectures and practical classes are announced for this term:—

Prof. Pritchard is to lecture at the Observatory on "Planetary Theory" and on "Astronomical Instruments and Methods," and offers practical instruction. Prof. Bartholomew Price lectures at the Museum on "Optics."

At the Clarendon Laboratory Prof. Clifton continues his course on "Electricity," and Mr. Walker lectures on "Double Refraction treated Mathematically." The practical work remains in the hands of the Professor, Mr. Walker, and Mr. Selby. Sir John Conroy, who has undertaken Mr. H. B. Dixon's work at Balliol and Trinity, lectures on "Elementary Electricity."

In the Chemical department Prof. Odling will lecture on the "Benzoic Compounds"; Mr. Fischer and Mr. Watts continue their systematic courses on "Inorganic" and "Organic Chemistry" respectively. Mr. C. J. Baker and Mr. Marsh assist in the laboratory teaching. In Mr. Vernon Harcourt's laboratory at Christ Church and in the Balliol Laboratory the usual work is to be carried on.

The arrangements in the department of Morphology have been somewhat disturbed by the appointment of Mr. Baldwin Spencer to the Biology Professorship at Melbourne. Prof. Moseley is to lecture on the "Comparative Anatomy of the Vertebrata," and is to have Mr. G. C. Bourne as Assistant Lecturer and Demonstrator. Mr. Barclay Thompson lectures on the "Osteology and Distribution of the Ichthyopsida."

In the new Physiological Laboratory, Prof. Burdon Sanderson lectures on the "Physiology of the Nervous System," Mr. Dixey on "Histology," and Mr. Buckmaster gives an elementary course of Physiology for the newly-organised preliminary examination. Practical instruction is given in Physiology by Mr. Gotch, in Histology by Mr. Dixey, and in Physiological Chemistry by Mr. Haldane.

Quite a number of men are beginning to read for the new Medical School. The dissecting-room is under the charge of Mr. Arthur Thomson, who lectures on the "Digestive System."

Prof. Prestwich is to lecture chiefly on "Ternary and Quaternary Geology," including the Glacial period and questions relating to the antiquity of man. Prof. Westwood lectures on the "Arthropoda."

At the Botanic Garden, Prof. Bayley Balfour lectures on "Vegetable Morphology and Physiology," and has both elementary and advanced instruction in practical Botany.

The Pitt-Rivers Anthropological Collection is now so far arranged that the formal opening will probably take place this term. All the cases on the ground floor of the new building have been arranged by Mr. Balfour. Dr. Tylor is to lecture on the "Development of Arts" as illustrated by the collection.

Next week the annual examination for a Radcliffe Travelling Fellowship begins.

SCIENTIFIC SERIALS

Bulletins de la Société d'Anthropologie de Paris, tome 9ème, 3ème fascic. 1886.—On the relations between the organs of touch and smell, by Dr. Fauvelle. In this paper the author considers the proposition advanced by M. Pozzi that the attitude of an animal is always in accord with the exercise of its predominant organ of sense. On this assumption the biped station would be the consequence of the predominance of vision over smell, and the attitude of quadrupeds the result of the relatively higher development of their sense of smell. In refutation of this view the writer argues that the relations between the organs of sight and smell in bipeds and quadrupeds are the result, rather than the cause, of their different stations, while he shows that wherever in the animal series the organs of sight would seem to have lost their importance in proportion to the development of the sense of smell the latter is aided by delicate organs of touch situated on those parts of the body which form its anterior side when moving forward. Thus in the vertebrates all the organs of the senses are situated at the cephalic extremity of the body.—On a woman with a tail. The case, reported by M. Melikoff, was observed by Dr. Eliséeff, of St. Petersburg, author of an interesting work on men with tails. According to the statement of the woman, who suffered great pain from her caudal appendage, a similar abnormality had been observed in several female members of her family, in all of whom it had appeared between the ages of 12 and 17 years. Dr. Eliséeff refers this formation to embryogenic causes, such as an arrest of development in the fœtus, and observes that such cases are more frequent in males than in females, the latter, according to him, presenting a much more advanced corporeal development than men.—A case of double uterus, by Dr. Landowski.—On short-tailed dogs, by M. Duval.—Observations on the crania of several insane subjects, by M. Manouvrier.—On the weight of Gambetta's brain, by M. Duval. This paper, and the discussion to which it gave rise, are especially interesting from the new light which they throw on the assumed relations between the large volume of the brain and intellectual capacity, the weight of Gambetta's being only 1160 grammes, or, according to M. Duval, 1246 after making all possible allowance for accidental diminution by faulty methods of preparation, while the mean for persons not gifted with more than ordinary intelligence is 1360 grammes.—On a new variation of the ossa wormiana, by M. Manouvrier.—A case of pilosity in a young Laotian girl, by Dr. Fauvelle.—On acclimatisation in reference to French colonisation, by Dr. Fauvelle.—On the anthropological characteristics of the Indo-Chinese peoples, by Dr. Maurel.—On the origin of the bronze and tin of prehistoric times, by Mme. Clémence Royer. The writer believes that Europe supplied the sources whence bronze implements were fabricated by early man, while M. Mortillet considers that both the material and the production of the weapons, ornaments, and other objects of this kind which belong to prehistoric times must be referred to India and the Far East.—Enumeration of the megalithic remains of Nièvre, by Dr. Jacquinot. The number of such remains in the whole of France, as certified by official inquiry, amounts to 6310, of which thirty-five belong to Nièvre. Among these special interest attaches to the horizontal slabs of Saint Agnan, which Dr. Jacquinot considers to have been altars for human sacrifices.—Summary of the answers given by New Caledonians to the interrogatories of the Society of Sociology and Ethnography, by M. Moncelon. These answers supply interesting materials for the ethnographic study of these races, and show the importance of following a definite plan in pursuing such inquiries.—Anthropological observations of the Khmer tribes of Cambodia, by Dr. Maurel. The writer, who supplies numerous anthropometric measurements, believes that these peoples belong to the Mongolian group.

Rendiconti del Reale Istituto Lombardo, November 11, 1886.—Meteorological observations made at the Brera Observatory, Milan, during the months of August and September.

November 25.—Results of the experiments carried out at the experimental farm of the Royal Milanese School of Agriculture against the mildew of the grape-vine, by Prof. Gaetano Cantoni. Of the various methods of treatment here described, the preparation of a sulphate of copper dissolved in water in the proportion of three per thousand is shown to be the most efficacious. The analysis of the wines obtained from crops so treated shows that they usually contain a scarcely appreciable quantity of the copper.

Bulletin de l'Academie des Sciences de St. Petersbourg, tome xxi. No. 2.—Report on a memoir by M. Harzer on a special case of the problem of the three bodies, by O. Backlund. It is considered a most valuable work, being the first attempt to apply the method of Prof. Gyldén.—New transcription of the Castrén's Koibal dictionary and Koibal poetry, made by M. Katanoff (who is himself of Sagai origin), from the Abakan, with a preface by W. Radloff.—Photometric researches on the diffusion of light, by O. Chwolson, being numerical data of new experiments mathematically treated.—Hydrological researches, xlv. to xlvii., by C. Schmidt.—Chemical analyses of water from lakes in North-west Mongolia and in North Tibet.—On a differential equation, by B. Ichmenetzky.

SOCIETIES AND ACADEMIES

London

Royal Society, November 25, 1886.—"On the Dynamical Theory of the Tides of Long Period." By G. H. Darwin, LL.D., F.R.S., Fellow of Trinity College, and Plumian Professor in the University of Cambridge.

Laplace sought to show that, as regards the oscillations of long period, called by him "of the first species," friction would suffice to make the ocean assume at each instant its form of equilibrium. His conclusion is no doubt true, but the question remains as to what amount of friction is to be regarded as sufficing to produce the result, and whether oceanic tidal friction can be great enough to have the effect which he supposes it to have.

In oscillations of the class under consideration, the water moves for half a period north, and then for half a period south. Now in systems where the resistances are proportional to velocity, it is usual to specify the resistance by a modulus of decay, namely, that period in which a velocity is reduced by friction to $1 \div 2{\cdot}783$ of its initial value; and the friction contemplated by Laplace is such that the modulus of decay is short compared with the semi-period of oscillation.

The quickest of the tides of long period is the fortnightly tide, hence, for the applicability of Laplace's conclusion, the modulus of decay must be short compared with a week. Now it seems practically certain that the friction of the ocean bed would not much affect the velocity of a slow ocean current in a day or two. Hence we cannot accept Laplace's hypothesis as to the effect of friction.

This paper then gives a solution of the equation of motion when friction is entirely neglected. The method is indicated in a footnote to a paper by Sir William Thomson (*Philosophical Magazine*, 1875, vol. 50, p. 280), but has never been worked out before.

It appears in the result that with an ocean 1200 fathoms deep, covering the whole globe, the fortnightly tide has about 1/7th of its equilibrium value at the pole, and nearly a half at the equator. If the ocean be four times as deep we get analogous results, and it appears that with such oceans as we have to deal with the tide of long period is certainly less than half its equilibrium result.

In Thomson and Tait's "Natural Philosophy" (edition of 1883) a comparison is made of the observed tides of long period with the equilibrium theory.

This investigation was undertaken in the belief of the correctness of Laplace's view as to the tides of long period, and was intended to evaluate the effective rigidity of the earth's mass.

The present result shows that it is not possible to attain any estimate of the earth's rigidity in this way, but as the tides of long period are distinctly sensible, we may accept the investigation in the "Natural Philosophy" as generally confirmatory of Thomson's view as to the great effective rigidity of the whole earth's mass.

There is one tide, however, of long period of which Laplace's argument from friction must hold true. In consequence of the regression of the nodes of the moon's orbit there is a minute tide with a period of nearly nineteen years, and in this case friction must be far more important than inertia. Unfortunately this tide is very minute, and as is shown in a Report for 1886 to the British Association on the tides, it is entirely masked by oscillations of sea-level produced by meteorological or other causes.

Thus it does not seem likely that it will ever be possible to evaluate the effective rigidity of the earth's mass by means of tidal observations

December 9.—"Note on a New Form of Direct-Vision Spectroscope." By G. D. Liveing, M.A., F.R.S., Professor of Chemistry, and J. Dewar, M.A., F.R.S., University of Cambridge.

December 16, 1886.—"Preliminary Account of the Observations of the Eclipse of the Sun at Grenada in August 1886." By Captain Darwin, R.E. Communicated by Lord Rayleigh, Sec.R.S.

The instruments allotted to me consisted of the coronagraph and the prismatic camera; the two instruments being mounted on the same equatorial stand.

The photograph obtained with the prismatic camera shows several images of the prominences, and it therefore gives every promise of yielding good results when measured and examined.

The five- and ten-second photographs of the corona show signs of a slight vibration, but they will be useful for the inner part of the corona. As my main object was to obtain instantaneous photographs, these long-exposure plates had to be obtained by working the automatic shutter by hand; it was this probably that caused the vibration.

The instantaneous photographs of the corona when developed were complete blanks, proving that the exposure was too short. It should, however, be observed that this does not prove that the light of the corona was insufficient to cause an appreciable effect on the plate if combined with other light. More light energy is necessary to start photographic action than is required to produce a visible difference of shade when once the action is started.

Many of the photographs taken during partial eclipse show what may be described as a false corona, that is, an increase of density near the sun and between the cusps, or *in front of* the moon. In none of them can the moon be seen eclipsing the corona.

The results, therefore, are adverse to the possibility of obtaining photographs of the corona in sunlight; it is, however, I consider, by no means proved that the method is impossible. But at present I am inclined to consider that the result tends to show that a *practical* method of obtaining photographic records of the corona during sunlight is not likely to be obtained. The trial was not conclusive because the conditions were very unfavourable. In order to reduce the air-glare to a minimum, so that the light of the corona shall not be overpowered, the following points must be observed:—

(1) The air should be clear and dry.

(2) The sun should be near the zenith.

(3) The station should be at a considerable elevation above the sea.

(4) The corona, if it does vary in intensity, should be at its maximum brightness.

Now every one of these conditions was unfavourable. The air was saturated with moisture, the sky was of a hazy blue, the sun was low, the station was near the sea-level, and the corona, according to the general impression, was not so bright as on other occasions.

I hope, however, to deal more fully with these considerations on another occasion.

Mathematical Society, January 13.—Sir J. Cockle, F.R.S., President, in the chair.—Prof. G. B. Mathews was elected a Member.—The following communications were made:—Conjugate "Tucker" circles, by R. Tucker.—On the incorrectness of the rules for contracting the processes of finding the square and cube roots of a number, by Prof. M. J. M. Hill.—On the complex angle, by J. J. Walker, F.R.S.—Shorter communications were also made by Messrs. Heppel, Macmahon, and S. Roberts, F.R.S., in the discussion of which several members took part.

Victoria Institute, Jan. 3.—Dr. Wright read a paper describing the Hittite monuments which he had examined in the East, and giving an account of the present position of the question as to the age and extent of the country of the Hittites. Many afterwards joined in the discussion. Thirty members and associates were elected, and it was announced that 100 had joined during the past year, making 1200 members the Institute's strength.

Edinburgh

Mathematical Society, January 14.—Mr. W. J. Macdonald, Vice-President, in the chair.—Prof. Chrystal gave a paper on the generation of any curve as a roulette; and Mr. William Renton contributed some mnemonics for plane and spherical trigonometry.

Paris

Academy of Sciences, January 10.—M. Gosselin in the chair.—Note on the works of the late M. Oppolzer, Corresponding Member of the Section for Astronomy, by M. Tisserand. In this obituary notice reference is made more especially to the eminent astronomer's "Traité des Orbites," his determination of the orbits of the planets and many comets, and his theory of the movement of the moon.—On various phenomena presented by the artesian wells recently sunk in Algeria, by M. de Lesseps. The results are described of unusually successful operations undertaken in 1885 and last year in the region of the Shotts, where one well, yielding as much as 8000 litres per

minute of pure water at a temperature of 25° C., has already developed a considerable lake 10 metres deep, by means of which from 500 to 600 hectares of waste land have been reclaimed. Similar results elsewhere give hope that large tracts now uninhabited, but which supported a numerous population in the time of the Romans, will soon be again brought under cultivation.—On the theory of algebraic forms with *p* variables, by M. R. Perrin.—On the action of the chloride of carbon on the anhydrous oxides, by M. Eug. Demarçay. Schützenberger having shown that the tetrachloride of carbon reacts readily on the sulphuric anhydride, forming phosgene and chloride of pyrosulphuryl, the author here describes some experiments he has carried out for the purpose of ascertaining whether the same substance reacts on the oxides, and whether this reaction might not be utilised in the laboratory for facilitating the preparation of the anhydrous chlorides.—On erythrite, by M. Albert Colson. This substance should yield successively by oxidation a monobasic and a bibasic acid, the latter being tartaric acid, according to Henninger's formula. But no monobasic acid derived from erythrite has yet been described, nor has the transformation of this alcohol into tartaric acid ever given satisfactory results. The author here accordingly resumes the study of its oxidation, testing by the thermo-chemical process the formulas hitherto accepted for erythrite and tartaric acid. He also treats erythrite with the perbromide of phosphorus, obtaining a bromhydrine, $C_4H_6Br_4$, fusible at 112° C., and identical with the tetrabromide of crotonylene, described by Henninger.—On the glycerinate of potassa, by M. de Forcrand. Having already determined the heat of formation of the glycerinate of soda, and of its ethylic combination, and the conditions under which these compounds have their origin, the author here subjects the glycerinate of potassa to a similar process with analogous results.—On the substances derived from erythrene, by MM. E. Grimaux and Ch. Cloez. The object of the experiments here described is to ascertain whether erythrene and the carburet of gas oils are really identical, as supposed by Henninger. The result so far shows that the erythrene derived from the oils of compressed gas unites readily with hypochlorous acid, the product of the reaction being soluble in ether, alcohol, and water.—On the artificial production of zincite and willemite, by M. Alex. Gorgeu. The methods by which the author reproduces zincite are based on the decomposition of several salts of zinc by heat alone, or aided by the vapour of water. It is merely an application of the process by which M. Debray has obtained crystals of glucine, magnesia, &c. Willemite, $SiO_2,2ZnO$, he produces by a method based on the action of silica on a mixture of alkaline sulphate and sulphate of zinc.—Observations on fishes inhabiting very deep waters (second communication), by M. Léon Vaillant. The really characteristic types of this class of deep-sea fauna are referred to the sub-order of the Anacanthini, which yields a considerable number of species, living at great depths. There is almost a total absence of Pleuronectes, the solitary exception being *P. megastoma*, Donov., fished up from a depth of 560 metres. A striking feature of this ichthyological fauna is its great uniformity, the same genera and even closely-allied species constantly reappearing and being evidently diffused over the widest ranges.—Researches on the mechanism of respiration in the Myriapods, by M. J. Chalande. Most zoologists suppose that the breathing process is the same in the Myriapods as in insects; but the author's researches show conclusively that this hypothesis is absolutely erroneous. In them respiration is effected by the rhythmical movements of the dorsal vessel, the air also penetrating by diffusion to the most delicate tracheæ.—On the age of the Bauxite formation in the south-east of France, by M. L. Collot. This formation, which in the Ariège district occurs between the Coralline and Urgonian deposits, is referred to the successive geological epochs between the Lower Lias and the Urgonian.—On the partial results of the first two experiments made to determine the direction of the North Atlantic currents, by Prince Albert of Monaco. Of the 169 floats cast overboard 300 miles north-west of the Azores in 1885, fourteen have been recovered, showing a general south-easterly direction and a mean velocity of 3·83 miles per twenty-four hours. Of the 510 floated in 1886 much nearer to the French coast, nine have reappeared, showing nearly the same direction, with velocities of from 5·80 to 6·45 miles.—Coincidence of certain solar phenomena with the perturbations of terrestrial magnetism, by M. E. Marchand. A comparative study of the solar observations made at the Lyons Observatory in 1885-86 with the curves of the Mascart magnetic recorder shows that there exists a direct relation between the terrestrial magnetic disturbances and the displacements of certain solar elements accompanying the spots and the faculæ.—On the actual value of the magnetic elements at the Parc Saint-Maur Observatory, by M. Th. Moureaux.—Note on the recent minimum of the solar spots, by M. A. Riccò. This minimum, which occurred between October and December, 1886, was specially remarkable for its intensity, no spots or pores being at all visible twice for eleven days and once for eight days during that period.—Remarks on the geological chart of Lake Baikal and the surrounding district, by M. Venukoff. A careful study of this map, drawn to a scale of 1 : 420,000, shows that the Baikal basin is not a *crevasse* in the Jurassic beds, as had been supposed, nor a subsidence due to plutonic or volcanic causes, but that its formation dates from pre-Silurian times and is still in progress.

BOOKS AND PAMPHLETS RECEIVED

Practical Zoology: Marshall and Hurst (Smith, Elder).—The Garner, vol. i. (Bowers, Walworth).—Massachusetts Institute of Technology—Twenty-second Annual Catalogue of Officers and Students, and President's Report (Boston).—Folk-Lore and Provincial Names of British Birds: Rev. C. Swainson (Stock).—Flora of Leicestershire (Williams and Norgate).—Journal of the Franklin Institute, January.—Transactions of the Yorkshire Naturalists' Union, Parts 7, 8, 9 (Taylor, Leeds).—Precious Stones in Nature, Art, and Literature: S. M. Burnham (Trübner).—Health at Schools: Dr. C. Dukes (Cassell).—Deviation of the Compass in Iron Ships: W. H. Rosser (Imray).—Sonnets on Nature and Science: S. Jefferson (Unwin).—Logia of the Lord; Historical Jesus; Paul the Gnostic Opponent of Peter; Devil of Darkness: G. Massey.—Report of Kew Observatory Committee for the Year ending December 31, 1886 (Harrison).—Explication des Taches du Soleil: M. Delauney (Paris).—Elementary Ideas, Definitions, and Laws in Dynamics: E. H. Hall (Cambridge, Mass.).—Studien über das Molekular-volumen einiger Körper: G. A. Hagemann (Friedländer, Berlin).

CONTENTS

	PAGE
The Imperial Institute	265
The Blastoidea	267
Tea-Planting in Ceylon	268
Geometry	269
Acoustics	270
Our Book Shelf:—	
Phillips's "Old or New Chemistry"	270
Clifford's "Lectures and Essays"	270
Jeans's "Lives of the Electricians"	270
Letters to the Editor:—	
Normal School of Science and Royal School of Mines.—**Colonel J. F. D. Donnelly, C.B.**	271
The Cambridge Cholera Fungus.—**Walter Gardiner**	271
Snowstorm of January 7, 1887.—**E. J. Lowe.** (*Illustrated*)	271
Auroras.—**Dr. M. A. Veeder**	272
A Solar Halo.—**J. J. Walker**	272
The National Science Collections, II.	272
Transmission of Power by Compressed Air. (*Illustrated*)	275
The Classification of the Cæcilians	280
Notes	280
Our Astronomical Column:—	
New Variables in Cygnus	282
New Minor Planet	282
A New Method for the Determination of the Constant of Aberration	282
The Madras Observatory	282
Astronomical Phenomena for the Week 1887 January 23-29	283
Geographical Notes	283
Experimental Science in Schools and Universities	284
Aboriginal Art in California and Queen Charlotte's Island	285
University and Educational Intelligence	285
Scientific Serials	286
Societies and Academies	287
Books and Pamphlets Received	288

dis-
and
the
on
This
886,
eing
ring
ikal
tudy
the
been
but
l in

rner,
gy—
Pre-
ritish
and
s of
cious
ealth
Iron
ffer-
nostic
Kew
son),
ntary
idge,
. A.

AGE
265
267
268
269
270
270
270
270
271
271
271
272
272
272
275
280
280
282
282
282
282
283
283
284
285
285
286
287
288